INDUSTRIAL ENGINEERING

with which is consolidated

INDUSTRY ILLUSTRATED

Electrical, Mechanical and Plant Service in Industry

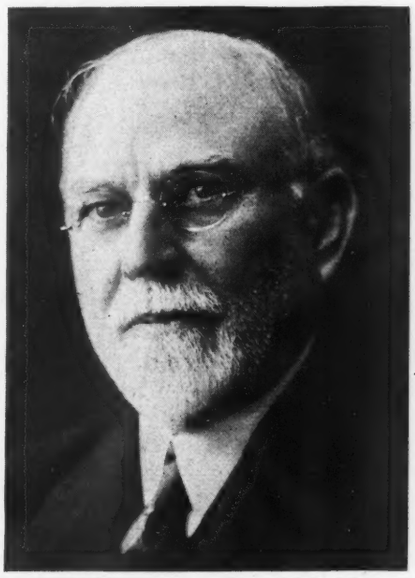
Published by McGraw-Shaw Company

Volume 86 NEW YORK, MARCH, 1928 *Number 3*

JAMES H. McGRAW *awarded* BOK GOLD MEDAL *for Distinguished Service in Advertising*

JAMES H. McGRAW, president of the McGraw-Hill Publishing Company, Inc., chairman of the McGraw-Shaw Company and chairman of the McGraw-Hill Book Company, was presented the Harvard Advertising Award for Distinguished Services to Advertising (in 1927), highest of ten awards established by Edward Bok, at a dinner held on Friday night, Feb. 17, under auspices of the Graduate School of Business Administration of Harvard University. The award takes the form of a gold medal given to the "individual or organization deemed by the jury of award to merit recognition for contemporary services to advertising." The medal bears the inscription: "To James H. McGraw—For distinguished personal service rendered American commerce and industry through raising the standards of advertising—1927."

The Bok Awards are administered by the Graduate School of Business Administration of Harvard University. They are offered in the conviction that advertising, wisely utilized, is a great economic power to broaden markets and decrease the cost of distributing goods; but, if unscientifically employed, is wasteful to the community. The prizes are given for the best work in advertising within the terms of the several awards in accordance with the decisions of a jury of award appointed by the dean of the Harvard Business School.



The following quotations from the Harvard University announcement of the award indicate the reasons for bestowal of the medal upon Mr. McGraw.

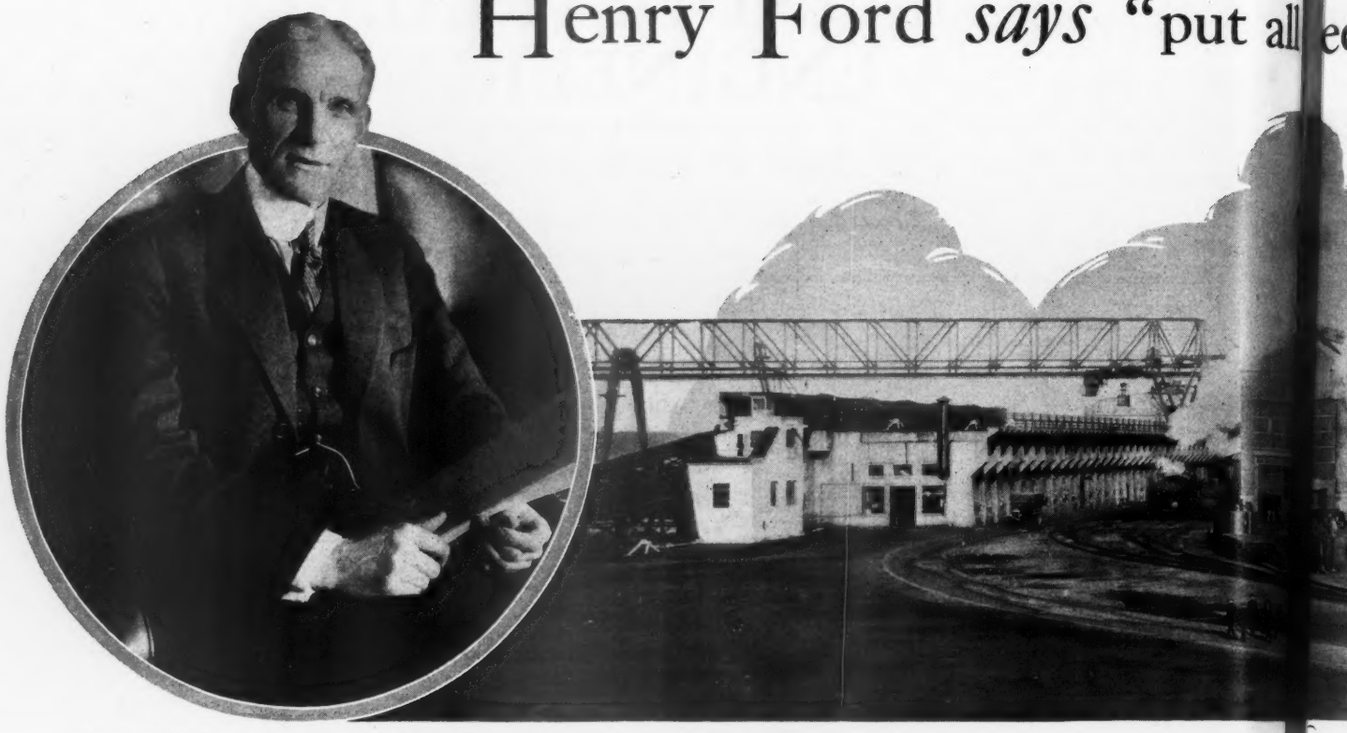
1. James H. McGraw, president of the McGraw-Hill Publishing Company, Inc., was awarded the Gold Medal for Distinguished Contemporary Service to Advertising because of his life-long service in the upbuilding of higher standards in advertising in the business press of the country.

2. In making the award of the gold medal, which is the greatest honor in the series of Harvard Advertising Awards, Professor Sprague spoke of Mr. McGraw's pioneering work in the recognition of advertising's relation to marketing, and of his constructive services in the upbuilding of the highest advertising practices among the organized business press.

In the field of business publishing, Mr. McGraw has been a leader in securing adoption of the code of ethics and business practice which today governs the editorial, advertising, and business activities of the organized business press. He has been a pioneer in the recognition of the relation of advertising to marketing. Studies of industry's buying habits and the effective form of marketing organization for industrial products have done much to clarify industry's appreciation of the particular requirements of industrial marketing, as contrasted with the development of sales to the private consumer.

Mr. McGraw was born in Panama, Chautauqua County, New York, on Dec. 17, 1860. He came into publishing from the principalship of an upstate school. He is a member of many engineering, business and scientific organizations. Among these are the American Institute of Electrical Engineers, the American Society of Mechanical Engineers, National Electric Light Association, American Electric Railway Association, the Illuminating Engineering Society, Harvard Business Historical Society. He is the third person to be honored with the medal for distinguished services to advertising. The two men previously honored are Ernest Elmo Calkins, president of Calkins & Holden, and O. C. Harn, managing director of the Audit Bureau of Circulation.

Henry Ford *says* "put all e



Henry Ford and a view of the yard at Fordson, formerly called the River Rouge Plant

Maintenance F

at the F

As Told by FAY LEONE FAUROTE

HENRY FORD has said, "Put all machinery in the best possible condition, keep it that way and insist upon absolute cleanliness everywhere, in order that a man may learn to respect his tools, his surroundings and himself."

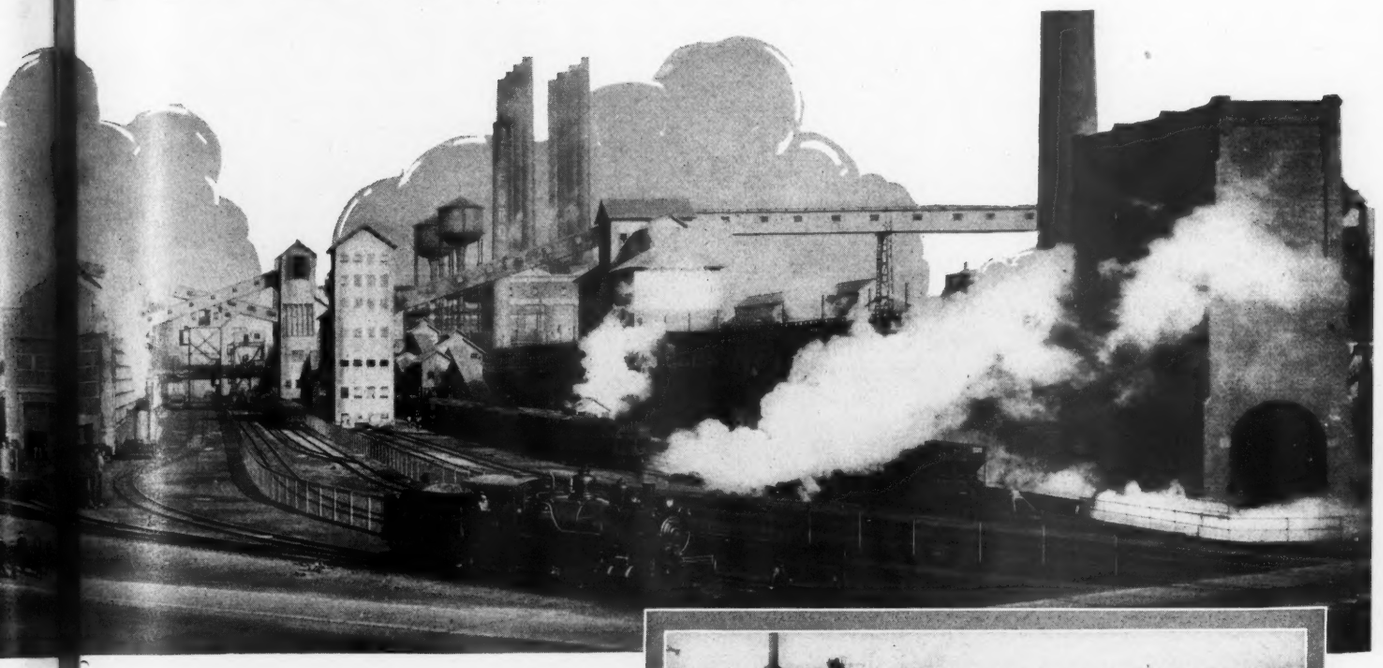
It is one thing to set up a standard, another to maintain it, but in the Ford Motor Company the standard *is* maintained. How Ford machinery is put in the best possible condition, carefully cleaned and polished, painted, and kept that way, is a story in itself. Such work is the job of the department of maintenance and construction; the department to which is entrusted a great variety of tasks, ranging from the simple inspection and maintenance of an electric motor or starting device, to the construction of a huge system of conveyors or a building balcony, the fabrication of a thousand steel safety guards, the reformation of thousands of feet of piping or hundreds of valves, the renewing of commutators, a rewinding of armatures and field coils, the complete rejuvenation of steam valves and fittings, the maintenance of the hot-water systems and the steam lines; in a word all of the tributary material and machinery, aside from that actually engaged in regular car production.

This department is therefore responsible for a multitude of things. It employs numerous painters, plumbers, steam fitters, bricklayers and helpers, construction workmen, carpenters, concrete workers, welders, glaziers, structural steel men, tinsmiths, riggers, tile setters and, in the maintenance department of the various buildings, electricians by the score; handy men of every trade.

One day they are engaged in lifting 58-ton boilers from ships, moving whole engines, or transferring gigantic punch and draw presses from one plant to another; the next week they may be putting in steel and concrete piers, laying floors and building balconies, installing tanks in the steel mill, reclaiming and restraightening salvage steel, piping, valves, copper tubing. In fact it would be hard to name anything which is, or might be used around a large industrial plant with which they do not at some time deal.

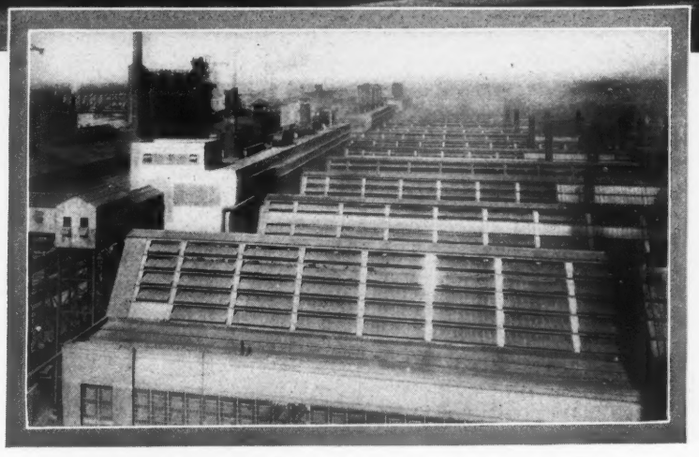
Most of their work is of such a varied character that finished drawings are never made. The work cannot be standardized. Each job is a separate one to be done for a specific purpose. Rough or semi-finished sketches are sufficient and the work is done by men who are skilled enough in their trades so that they require little more than a general explanation of the job at hand. And yet, the

equipment in shape and keep it that way"



Practices

Fordson Plant



Acres of roofs and 92 miles of railroad tracks indicate the extent of the Fordson plant

work goes on from day to day, week to week, and year by year, almost unnoticed in a plant the size of the Fordson on the River Rouge. But, like many other departments of this character, should it fail to function, its failure would at once manifest itself in the stoppage of production and in the complete tieup of one or more departments in the industrial chain.

It is for this reason that INDUSTRIAL ENGINEERING is presenting this general résumé of the work of this department and the manner in which it is planned and carried out.

In building AA, known as the fabricating shop, at the Fordson plant, are located many large machines used for fabricating sheet and structural steel, for reshaping and rebending pipe, for spot welding, for forming and riveting tin and sheet metal, for conduits, pipes, airducts, chutes, slides, shields and light metal parts of this character. On the floor of this shop are also a large automatic self-spacing die and punch press, a steel breaker, presses for shaping steel pipe up to 8 in. in diameter and for bending same to angles up to 90 deg., facilities for all kinds of structural fabrication, a blacksmith shop, and the usual group of machine tools needed for handling the unique jobs that are bound to come to a maintenance shop.

The fabricating shop at Fordson contains, besides the steel fabricating shop itself, a tin shop, a pipe shop and pipe salvage. It has a total floor space of 72,560 sq.ft. and is served by five 5-ton overhead cranes. These handle all the structural steel and are available for movement of machines or big repair jobs. There are, also, a number of 1-ton jib cranes which are used by the employees for lifting and holding material in place at punch presses or shears.

* * * *

Here is the equipment: an air compressor which furnishes 1,200 cu.ft. of air per min. at a constant pressure of 100 lb. per sq.in.; a large welding booth, where all electric and acetylene welding is done, contains three butt welding machines, one of which will weld machine steel up to and including 2-in. square, 4 x 4-in. angles or 4-in. I-beams; one 950-kva. butt welder which will weld a piece of steel 4-in. square, also another butt welder which will weld up to 6 x 6-in. angles, 7-in. I-beams and 7-in. channels; four bull riveters, one of 95-ton rating drives up to $1\frac{1}{2}$-in. rivets, one of 50-ton rating drives up to 1-in. rivets, one of 35-ton rating drives up to $\frac{7}{8}$-in. rivets, and one of 50-ton rat-

ing drives up to $1\frac{1}{8}$-in rivets; three double-end grinders; and one band saw which will cut steel up to 10 in. in diameter.

Also, two punch presses of 100-ton rating which will punch a 1-in. hole in 1-in. plate; five drill presses that will drill up to 1-, $1\frac{1}{4}$-, $1\frac{1}{2}$- and 2-in. holes in any thickness of steel up to $1\frac{1}{2}$ in.; two thread cutting machines for rods up to $\frac{5}{8}$ in. and another for rods up to 2 in. One 90-ton double-end punch press, four 90-ton single punch presses, one 50-ton punch press which will punch up to $\frac{3}{4}$-in. holes in a 1-in. plate; two 1,500-lb. air hammers, one 150-lb. air hammer and one 200-lb. Bradley helve hammer are used in the blacksmith shop for making forgings. One Ingersoll star drill, which takes up to $1\frac{1}{2}$-in. drills, is used throughout the plant for making holes in concrete or other like material.

Other equipment includes: four small tool grinders; one end-milling machine, which will take work up to 30 x 48 in., is used to mill the ends of columns and similar large areas; one cold riveter which rivets up to $\frac{3}{8}$ in.; one small flat-bar shears which will cut material up to $\frac{1}{4}$ x 3 in.; one plate shears which will cut up to $\frac{1}{4}$-in. plate 10 ft. wide; one breaker which will bend a $\frac{3}{4}$-in. plate, 12 ft. wide; two angle-iron shears which will cut any angles up to 8 x 6 x $\frac{3}{4}$ in.; one angle-iron roll which bends or rolls angle iron up to 6 x 6 x $\frac{3}{4}$ in.; one breaker which breaks $\frac{3}{8}$-in. plate up to 10 ft. wide, cold, or $1\frac{1}{8}$-in. plate, hot. One 360-ton double-end Thomas spacing machine is used to punch a number of holes at once in plates, I-beams, channels or angles. This machine does away with a considerable amount of work, as this material does not have to be laid out first.

In addition: one cold press, where channels, I-beams and angles, can be straightened without being heated; a 100-ton duplicate punch where several plates and a number of holes can be punched at the same time, also doing away with the laying out of channels; one coping machine, which will cope angles up to 4 x 4 in.; one column drill which will drill up to a 2-in. hole in 1-in. plate; one $\frac{7}{8}$-in. x 12-ft. squaring shears; one 10-ft. roll for plates up to 1 in.; two rotary shears which will cut up to $\frac{1}{4}$- and $\frac{1}{2}$-in. plate, respectively; one $\frac{1}{4}$-in. x 10-ft. breaker; one small power roll for plate up to $\frac{1}{4}$ in. x 6 ft.; and one radial drill; these machines, all of which are direct driven, comprise the equipment of the fabricating shop proper.

The tin shop contains: two 6-in. hand-lever cutting machines for steel up to 16 gage inclusive; one hand-lever angle cutter for angles up to $1\frac{1}{2}$ x $1\frac{1}{2}$ x $\frac{1}{8}$ in.; one hand-lever notching machine which is used to notch out $1\frac{1}{2}$ x $1\frac{1}{2}$ x $\frac{1}{8}$-in. angles; one power notching machine for sheet metal up to 14 gage; one power rotary shears for cutting sheet metal up to 16 gage; one power angle-rolling machine for angles up to $1\frac{1}{2}$ x $1\frac{1}{2}$ x $\frac{3}{16}$ in.; one small tool grinder.

Other equipment includes: one butt welder for welding angles up to $1\frac{1}{2}$ x $1\frac{1}{2}$ x $\frac{3}{16}$ in.; a 4-ft. and a 6-ft. hand breaker for sheet metal up to 22 and 20 gage, respectively; one power flanging machine for working sheet metal up to 16 gage; one spot welder rated up to 22-gage sheet metal; one 30-in. and one 36-in. hand roller which will take up to 22-gage sheet metal; two 4-ft. power rollers for 14-gage sheet metal; one power crimping machine which will crimp a piece of sheet metal up to 18 gage, and one power wiring machine. Three 14-gage, 10-ft. power squaring shears; three 8-ft. hand breakers and one 3-ft. hand folder which will handle 20-gage sheet metal; one power band-iron shear rated for steel $\frac{5}{16}$ in. thick and 4 in. wide; two drill presses used for drilling up to 1-in. holes in $\frac{3}{16}$-in. metal; one power gang punch which will punch 16 holes at one time in 14-

GENERAL VIEW SHOWING THE MACHINE ARRANGEMENT IN ONE OF THE FORDSON SHOPS

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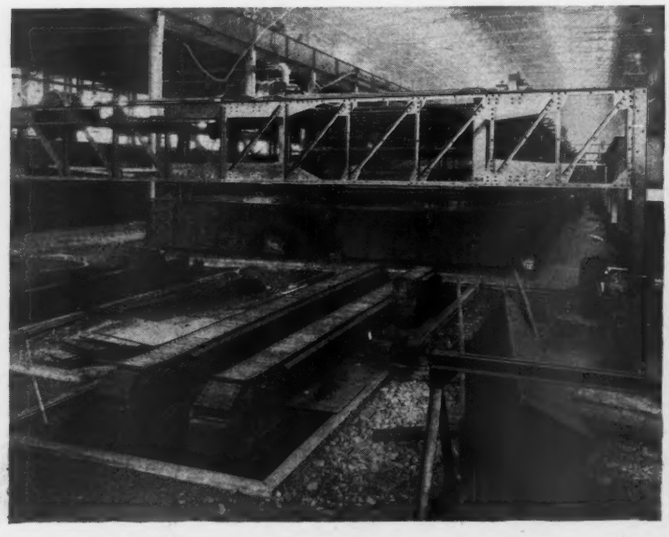
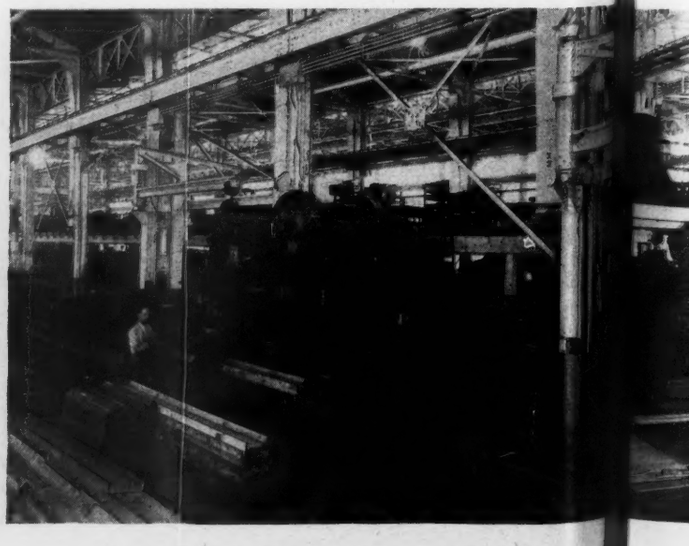
BUILDING PICKLING TANK AT BEGINNING OF FRAME PROCESS LINE—A TYPICAL JOB





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TIME IS SAVED BY USING A SPACING MACHINE WITH PUNCH PRESS FOR FABRICATING STEEL

gage sheet metal; one 6-ft. power roller which will roll a pipe up to 14-gage sheet metal; one 4-ft. seamer which will seam a 48-in. standard pipe up to 20-gage metal; two 8-ft. and one 10-ft. power breakers which are used on sheet metal up to 14 gage; three punch presses which will punch $\frac{7}{32}$-in. holes in up to 14-gage metal, and one rotary shears for cutting 14-gage plate.

Pipe working tools consist of: three Landis pipe machines for threading from $\frac{1}{4}$- up to and inclusive of 2-in. pipe, one for $2\frac{1}{2}$- to 4-in. pipe, inclusive, and one for $2\frac{1}{2}$- to 8-in. pipe, inclusive; one Keeler pipe machine is used to thread 8- to 18-in. pipe, inclusive; one Bandstone lathe for cutting pipe; one Humphreys bending machine for bending 1- to 2-in. pipe; one Federal bending machine for bending from $2\frac{1}{2}$- to 10-in. pipe; one Warner & Swasey pipe facing machine for $\frac{3}{8}$- to 2-in. pipe, inclusive.

* * * *

ONE OF THE SHEARS FOR CUTTING STEEL PLATE OR SHEETS USED IN PLANT CONSTRUCTION

Two 100-kva. and two 250-kva. butt welding machines are used to weld pieces of salvaged pipe together. One 10-ton Bliss press is used for straightening and nine presses are used for cutting salvage pipe. Also, five grinders, four lathes, two band saws, six threading machines, one friction saw, one seamer, two double-end brushes and two double-end motor brushes, are all used in working up salvaged pipe.

Building AA, which is of concrete, steel and glass construction, has a floor space of 62,320 sq.ft., to which has been added 9,960 sq.ft. of balcony space, thus giving a total of 72,280 sq.ft. The building is 480 ft. long and 134 ft. wide at its south end; at its north end it narrows to 100 ft. at 40 ft. from its end. One balcony is occupied by offices and a drafting room, the other by a tin shop. The accompanying illustrations show some of the equipment installed.

In addition to this fabricating shop, a number of small maintenance departments are located in the various buildings. For example, in building B there is a special maintenance department under the direction of the superintendent of building B. The motor building has a similar maintenance section. All of this work was formerly under the general jurisdiction of the maintenance department but about eight months ago a change was made whereby the special maintenance work in any one building was placed directly under the superintendant of that building; it was thought that in this way the work would be carried on faster and at less expense. This plan is being followed at the present time. This, of course, applied only to small maintenance jobs, not to the larger ones. Those which run over $100 and are of a more pretentious character are referred to the main maintenance department which, in turn, co-operates with the local maintenance department in the installation or repairs or additions, as the case may be.

At the present writing a number of large installations of balconies and conveyors are under way. Upon inquiry as to how fast such jobs would disappear after the new car was well into production, I was told by one of the men that at no time in his experience on maintenance work had he known of a time when there was not more of this work forthcoming. It had been his experience ever since he had been with the Ford Motor Company, which in his case went back some twenty years, that there was almost always more new construction each month than there had been the month previous. This phase of the work seems to be increasing rather than decreasing.

The second large division of the work is the steam fitting. All the large steam, water, air and general plant service pipes come under the jurisdiction of the maintenance department. This includes the hot-water heating system, the cooled-water drinking system, the fitting and care of valves; this is also general

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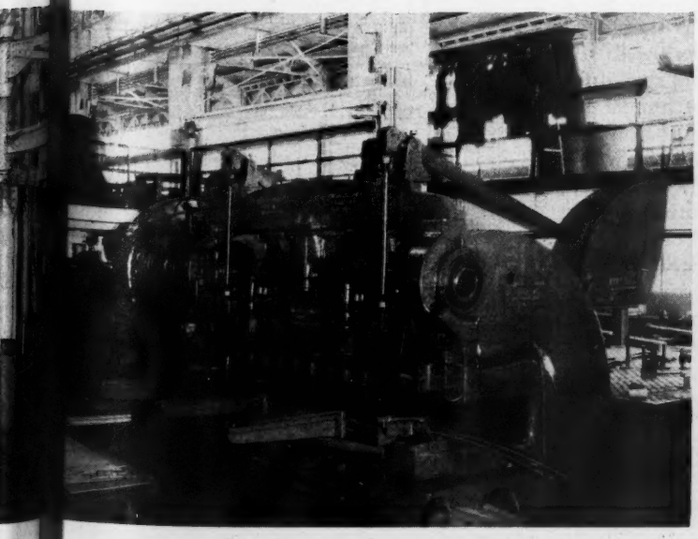
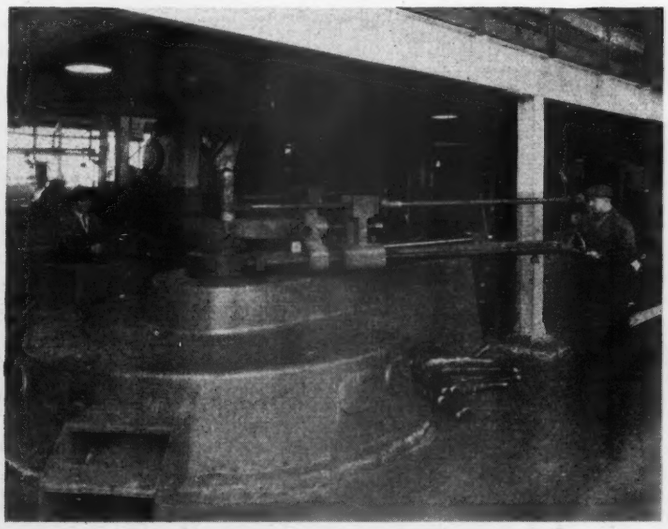
BENDING MACHINE FOR FORMING PIPE; SALVAGED PIPE IS STRAIGHTENED AND RE-USED





maintenance work. For example, a new tunnel going from the Spring and Upset building to the new administration building, which has just been completed, required the installation of a thousand-foot line for heat and water.

Of course the construction department has the usual amount of cement work, bricklaying, carpenter work, repair work, new foundations for machines, the salvaging of waste material of all kinds, especially the steel, piping, valves, and so on, which were taken from the ships which Mr. Ford purchased from the government some time ago. These materials have been rewelded into usable shape or cut to sizes suitable for use in construction and repair work.

A maintenance order may originate either in the maintenance department, the superintendent's office, or, in case of repairs to production machinery, with the foreman of the department or the superintendent of that building. These orders are sent to the maintenance department on a form; the general information as to the character of the job is given in the proper spaces and a general order is then issued to the fabricating shop, if the work is of this character. A rough sketch, such as the one illustrated, is then made and the work is put in progress.

On the blackboard, shown in an accompanying illustration, which is kept in the superintendent's office in the fabricating building, an accurate daily record and also a monthly record is posted showing the total amount of work in process, the number of men employed, the amount of work finished, the amount still ahead, the tonnage of steel used and other information of current value. This

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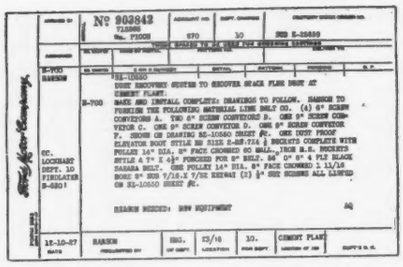
CHART IN SUPERINTENDENT'S OFFICE SHOWS PROGRESS OF CONSTRUCTION WORK



WORK ORDERS FOR NEW CONSTRUCTION ARE MADE OUT IN TRIPLICATE ON THIS FORM

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board is available to all executives in the department and shows at all times the work at hand and its progress.

On all production machinery, the oiler, as a rule, is held responsible for the condition of the machine; that is, he is the one who usually notices defects, indications of future failure, loose parts, worn surfaces, defective insulation, corroded parts, and so on. He generally calls it to the attention of the foreman of the department or the superintendent of the building, who, in turn, issues an order for the local maintenance department to take care of the defect.

Whenever possible this is done when the machine is idle, sometimes the work is done on Saturday, but never on Sunday; the only men employed in Ford shops on Sunday are the watchmen. The only exception is in cases of an emergency where it is absolutely impossible for the condition to remain until Monday morning.

The reclamation of the material from the government ships which Mr. Ford purchased has increased the duties of the maintenance and construction department very materially. This is a considerable undertaking. The amount of material, its diversity and the condition in which it is obtained make this reclamation problem one which taxes the ingenuity of a clever workman, and yet as I watched the work, I was impressed with the manner in which they would straighten out pipes, seemingly bent almost beyond hope of reclamation. Both the inside and outside of these pipes would be straightened, thoroughly cleansed, and in many cases painted. Short pieces of small pipes are butt welded to make longer pieces; pieces of sheet steel are also seam welded into larger sheets. Trays for automatic machine products, all kinds of safety guards, angle-iron sections, steel, valves, copper and brass piping and fittings come into the shop in a state of almost hopeless confusion and emerge as useful parts, going to the stockroom for regular requisition later. This material is placed in neatly corded piles in an open space.

Each maintenance department in a building has its own small stockroom and toolroom; the size of the department depends upon the nature of its work. The one adjacent to the coke ovens, for example, is very small, but complete. It has its own stockroom, toolroom, grinder, radial drill, metal saw and punch press. Only a few men are employed here.

On the other hand, one of the larger maintenance departments, that takes care of all the electrical motors, electrical measuring instruments and work of that character, employs several hundred men. Motors in every stage of construction may be seen; armatures are being wound, commutators repaired and cleaned, field coils rewound, delicate electrical measuring instruments repaired and tested. A gang of special emergency men is maintained whose duty it is to go direct to the machine on the floor and make such temporary repairs as may be necessary at the time; when necessary they substitute a new motor for the defective one and bring the latter back on a small truck to this balcony shop for complete overhauling.

And a complete overhauling means just that in the Ford Motor Company shop. Never have I seen such a high standard in repair work. When the job goes out it looks as if it had just come from the receiving room. Incidentally many of the finer micrometers and gages are sent to the Trade School for overhauling, a school in which boys 12 to 18 years of age are taught to do such fine work that when a micrometer comes back from their department it is hard to tell it from a new one.

(Please turn to page 149)

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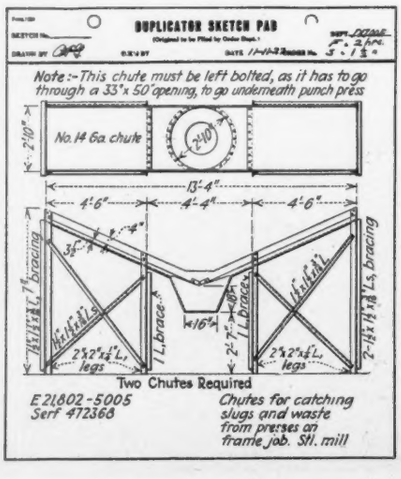
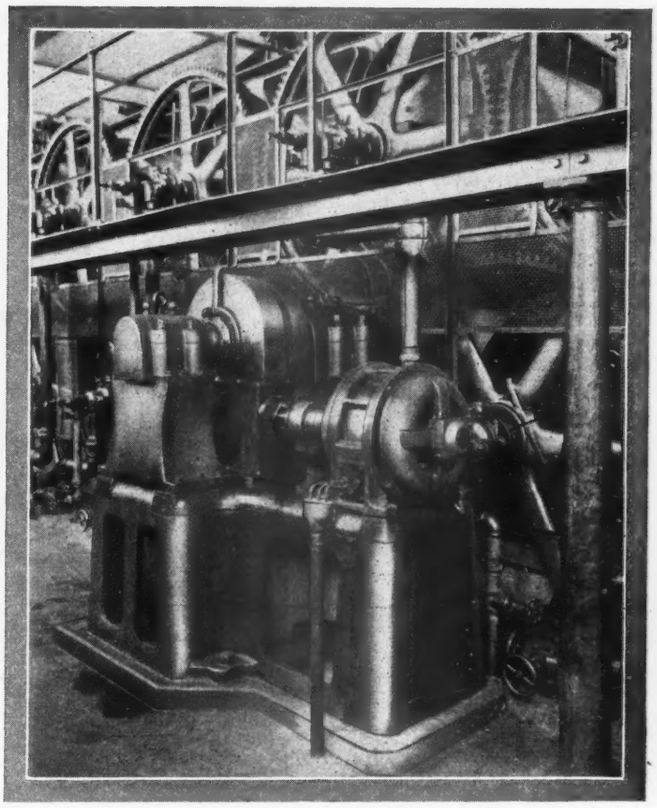
MOST NEW CONSTRUCTION JOBS ARE FABRICATED FROM ROUGH SKETCHES, SUCH AS THIS



Adding Life to GEAR DRIVES

By M. T. SCHUMB
Engineering Department
Boston Gear Works
Norfolk Downs, Mass.



An installation of gear drives that suggests permanence

CONTINUOUS and efficient operation of all types of gear drives depends to a large extent upon the attention given to installation, inspection and general maintenance. This is also true of speed reducer and chain drives, although these generally run under more ideal operating conditions than does open gearing. Due, in part, to the electrification of industrial processes speed reducers are finding an ever-widening field for industrial power transmission.

It is, of course, fundamentally important that the right type of speed reducer be selected in each specific case and, granting that this is done, with proper attention to installation and maintenance an efficient speed reducer drive will be the result.

In installing a speed reducer drive, a sturdy and level foundation is very necessary. If the foundation is of cement, it should be thoroughly seasoned, because any subsequent shrinkage will probably cause mis-adjustment of the entire set-up. Use of a good grade of flexible coupling is recommended for connecting the speed reducer to the motor.

When forcing the collar or the gear on to the shaft care should be taken that the end of the shaft is properly backed up, so that the driving shock may be absorbed as completely as possible. If this is not done injury to the bearing or to the gears will result. Loose or worn bearings are frequently the cause of much trouble in the operation of speed reducer drives.

Adequate lubrication is a very important factor in the efficient operation of gear drives, particularly of speed reducers and chains. A steam cylinder oil is generally found to be the best lubricant for speed reducers, of the worm and gear type. Very heavy oils or greases should not be used, except for very slow moving drives or when especially recommended.

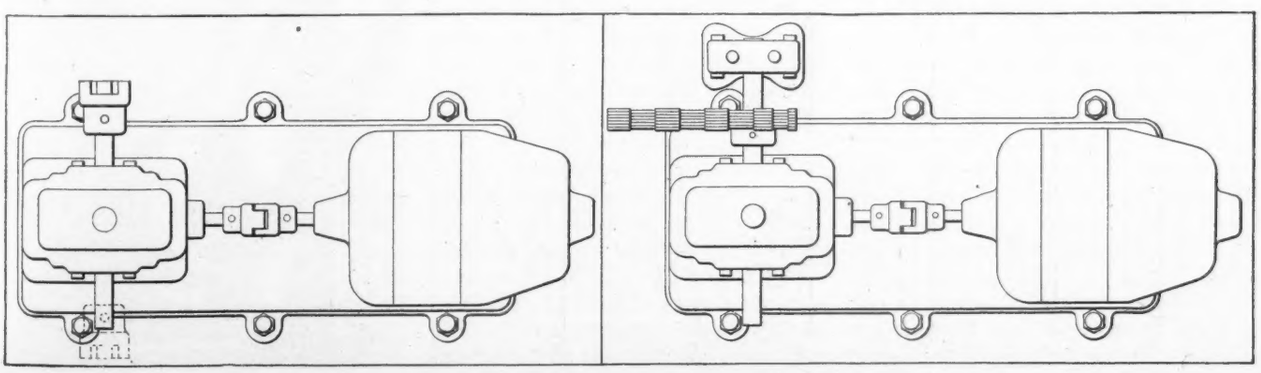
Almost all modern types of speed reducers are equipped with an oil level inspection device. Before operating any type of drive fill the speed reducer with oil to the proper level but no higher. It is advisable after the

* * * *

FIG. 2—FLEXIBLE COUPLINGS are used here to connect the motor to the high-speed shaft of the reducer and also the output or slow-speed shaft of the reducer to its machine. This connection is recommended for all torque loads and should be used wherever possible.

* * * *

FIG. 3—THE OUTBOARD BEARING is recommended when silent chains, gears or belts are used to connect the speed reducer to its load. It supports the end of the shaft and divides the transmission load over two bearings instead of applying heavy pressure upon the reducer bearing.



drive has been in operation for a reasonable length of time to drain off the oil and refill the housing with fresh oil to the proper level. With reasonable care and periodical inspection this need not be done thereafter more often than once or twice yearly.

The oil level should, however, be inspected about once a month, depending upon the duty. This inspection is carried out to the best advantage while the speed reducer is idle, but not cold. If, upon inspection, it is found that the oil does not flow, the oil level should be raised; care should be taken, however, to see that there is no excess of oil, because undue churning of oil will cause speed reducers to become overheated and will result in loss of power.

At the time of these inspections it is well to try all bolts for looseness and shafts for alignment. Should oil leakage, other than a few drops, occur at the shaft the gland requires tightening. Care should be taken that the gland is not unevenly or excessively tightened; to do so will cause oil leakage, possibly overheating and undue wear on shafts. If a speed reducer drive, particularly of the worm gear type, becomes suddenly overheated or leaks oil, an immediate inspection of the oil level should be made, because improper lubrication will generally be found to be the cause of either of these conditions.

If careful attention is given to these details pertaining to the erection, inspection and maintenance of speed reducer drives they will give long life even under the most severe industrial conditions, provided, as stated before, the type of unit selected is the most suitable for the service.

Figs. 2 and 3 illustrate the recommended installation practices for speed reducer drives. If a gear or chain drive is necessary the best practice is to place it on the reducer driven shaft and use an outboard bearing, as shown in Fig. 3.

The mechanical principles governing the installation and maintenance of speed reducer drives also apply in general to chain drives. For example, chain drives should be mounted as close to the bearing as possible. A suitable hanger for outboard bearings should be employed in order to insure a substantial mounting. The motor should be firmly bolted down to prevent movement or turning and also to eliminate as much of the inevitable vibration as is possible. It is important that the pinion be lined up in the mid-portion of the play of the alignment shaft.

The best mounting position for a chain drive is with its axis inclined at about 60 to 70 deg. from the horizontal with the large wheel above and the tight side of the chain on top. In this position the wheels on the slack side permit easy disengagement; also, the weight of the chain is carried by the large sprocket wheel and there is no excessive pull, due to the weight of the chain, on the shaft bearings.

Correct alignment is a very important factor in the efficient operation of chain drives and it is absolutely essential that careful attention be given to it. Fig. 4 illustrates correct alignment and some of the more common forms of misalignment.

As with speed reducers, proper lubrication is an important factor in the satisfactory operation of chain drives of all types A medium-heavy pure mineral oil is the most satisfactory lubricant for chain drives. Generally speaking, graphite greases are not desirable for chain drive lubrication because they leave deposits on the surface of the chain, which prevent any of the lubricant getting into the chain joints. Pure graphite grease, however, if not heated to a temperature exceeding 170 deg. F., will give satisfactory results for a considerable period but the graphite must be pure. Fig. 5 illustrates the use of drip feed lubrication on chain drives. This ensures an even distribution of oil.

If a chain becomes gummy during the course of operation it should be cleaned with kerosene; following this treatment the chain should be properly lubricated. In some cases there is a tendency on the part of the chain links to crowd together. In such cases the links should be spread out so that they occupy the full length of the pins, and then well lubricated with oil.

Chain drives should not be operated either very tight or too loose, and some provision for possible readjustment for wear should also be made.

* * * *

FIG. 4—CORRECT ALIGNMENT AND FORMS OF MISALIGNMENT. Misalignment is one of the most common causes of chain trouble. Here *AA* illustrates correct alignment where both sprockets have rims; *A* where only one sprocket has a rim. In *C* the shafts are parallel but the sprockets out of line. *D* and *E* illustrate the shafts out of parallel.

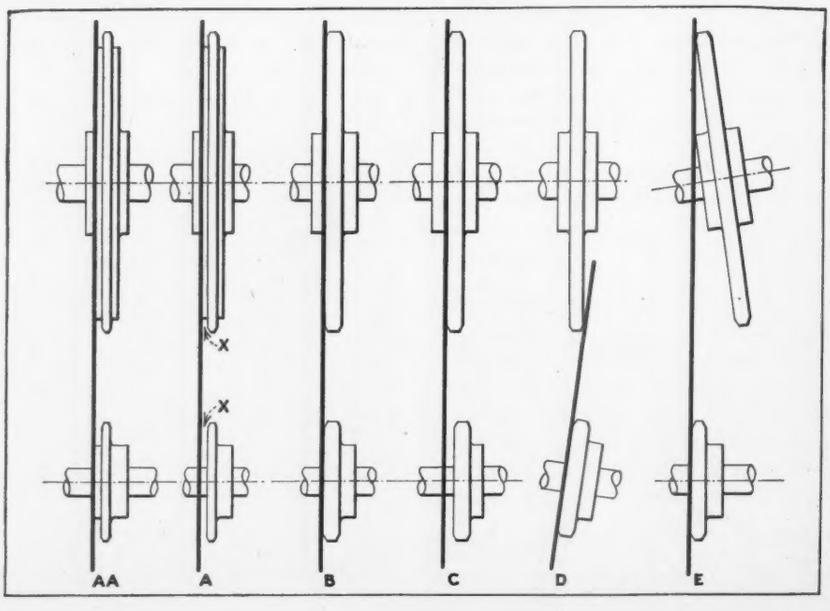
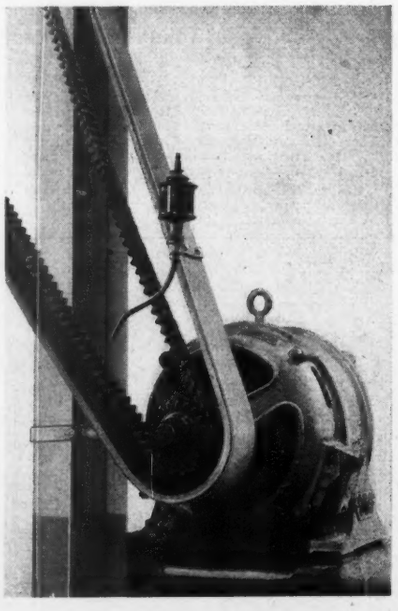


FIG. 5—DRIP FEED LUBRICATION ON CHAIN DRIVE. Proper lubrication has an important effect upon chain and sprocket wear. In this installation the lubricant is distributed by drip feed on the face of the chain which is protected by a splash guard. This form of lubrication ensures an even distribution of the oil, and in the proper quantity.



The final measure of lighting is the facility to see quickly, accurately, safely and comfortably

—says M. Luckiesh

Director Lighting Research Laboratory, General Electric Company Nela Park, Cleveland, Ohio

Expedite Lighting Maintenance

with Proper Planning and Proper Tools

SYSTEMATIC maintenance of lighting systems is as desirable as a good lighting installation itself. If maintenance has been considered and planned when the installation is being designed, the selection of lighting equipment is often very much influenced. Whether or not this has been done does not alter the fact that systematic maintenance is desirable. Obviously, the cost of maintenance should be compensated for by the gain resulting therefrom. Not all the factors contributing to this gain are readily computed. However, the cost of maintenance is usually compensated for by the cost of the light which is saved thereby.

There is no level of illumination which can be taken in any given case as the final level toward which lighting progress should strive. Intensities of illumination, in use and recommended at present, are far below those which the science of lighting indicates as desirable. For many years to come, intensities of artificial illumination will increase due to increasing knowledge and appreciation of the value of lighting in workplaces and, if history repeats itself, to the decreasing cost of light. Recommendations of illumination intensities by lighting specialists are very generally less than those which they believe to be most desirable and even economically practicable. This is due not only to a desire to be conservative, but also to the impracticability of making the user of light take the very large stride from his present low levels of illumination. This can best be done in several steps. Mankind has so recently and suddenly been projected from the age of feeble flickering light-sources into one of great possibilities in artificial lighting that much educational work and experience are necessary to shake off the shackles of tradition. For this reason the far-seeing designer of lighting installations recommends sufficient current-carrying capacity in the wiring in anticipation of progress in lighting for a decade or two.

A foot-candle meter substitutes certainty for guesswork

A direct loss through neglect of lighting equipment is that of electrical energy which produces that portion of the light absorbed by dirty equipment, neglected ceilings and walls, blackened bulbs of lamps which have lived their normal life, under-voltage of the lines, and improper combination of lamps and lighting unit. This direct loss increases directly with the hours per day during which the artificial lighting is operated. But there are indirect losses which may be far greater. Particularly at the present low levels of illumination, a reduction in the amount of light through inadequate maintenance means less work done, increased spoilage, more accidents, eye-fatigue, eye-strain, and less cheerful surroundings. All these make vision less efficient and less effective, and decrease the morale of the workers. The lowliest worker is still human and responds to his environment. He is entitled to adequate

light and surroundings as pleasant as economics permit. In many ways employers and other executives are showing that this responsibility is being recognized—and many have found that it pays. The same reasoning and experience should be applied to lighting.

The direct loss may be computed very readily if certain assumptions are made. Let us take a lighting unit containing a 200-watt lamp which operates 6 hr. per day for 24 days per month. In a month it uses 28.8 kw.-hr., which at 5c. per kw.-hr. costs $1.44. Suppose in a month the loss of light through dirt accumulation is only 7 per cent of the total. This is equal to 10c. which is about the cost of washing a lighting unit. Thus the maintenance costs nothing, even when only this one item is considered. All the other value of the increased illumination is profit.

If the accumulation of dirt is more or less or if the hours of operation of the lighting equipment are more or less, the computation may be altered accordingly.

The optical part of lighting equipment involves, besides the light sources, media which reflect, diffuse, refract, and transmit light. One area may be more important than another of a given lighting unit and one may be so located as to accumulate more dirt than the other. Some surfaces inherently hold more dirt and are harder to clean than others. A smooth surface, such as glass or enamel, is usually desirable. Furthermore, in places where dry dust abounds the lighting unit might be selected with its important reflecting or transmitting surfaces underneath, so that the dry dust cannot settle very thickly upon them. Vapor-proof and dust-proof units are available for certain work-places. These are tightly sealed devices consisting of proper glassware and usually equipped with porcelain-enameled metal reflectors.

For years it was taken for granted that the lighting units of larger wattages had to be ventilated in order that they might not overheat, and that they might not reduce the life of the filament lamp. Ventilation is largely a matter of tradition or habit formed in the past when it really was needed. Nothing more effectively illustrates the progress in light production creditable to the filament lamp. It supplies powerful light-sources in reasonably small volume and sealed tightly within glass. Ventilation is not essential for the light-source to operate. Furthermore, ventilation is not necessary even in large-wattage lighting units if the surface of the envelope is sufficient in area to dissipate the heat. It has been found that units of normal size ordinarily have sufficient surface area to accomplish this. Ventilation admits a great deal of dust, and is now reduced to a minimum or eliminated entirely in properly designed lighting units. Furthermore, it is sometimes found that ventilation carries heat upward so that sockets with paper insulation are damaged.

Unless ceilings are to be maintained at high reflection factor a lighting unit should not be selected which emits a large percentage of light upward. This upward light must be reflected from the ceiling. It reaches the work-area indirectly and, therefore, is termed the indirect component. Obviously, dirty ceilings absorb a good deal of light. Good lighting practice demands some illumination of the ceiling, but unless the surface is to be maintained reasonably well the upward component of light from the fixture should be small.

After such factors have been taken into account in the selection of lighting equipment, it is well to consider accessibility of the lighting units. Many of these are reached readily by means of a small ladder, but lowering devices are sometimes desirable. Lighting units may be hung on hooks and attached to convenience outlets In fact, much ingenuity can be exercised in the initial design if maintenance is borne in mind and its cost reduced to a minimum.

The accumulation of dirt varies widely, depending upon the location; therefore, it is difficult to present data for purposes of generalization. In cases of glass in windows and skylights it is not uncommon to find them so dirty that the transmission factor has been reduced to only a few per cent. In the machine shops lighting units are often found which are emitting only a fourth or a fifth of the light actually deliverable by the units when clean. This latter case means only 2 or 3 foot-candles at the work-plane in the case of the dirty units compared with 10 foot-candles when the equipment is clean.

THE RESULT OF INDIFFERENCE TO LIGHTING. Of course, maintenance was at the lowest ebb. The inadequate illumination from bare lamps and improper reflectors results in lowered production, decreased safety, visual discomfort, and general depression of workmen.

* * * *

Lighting equipment used under average conditions in factories and offices commonly depreciates 5 to 10 per cent in light output in the first month if not cleaned. In grinding rooms, wood-working shops, certain textile factories and similar places where dirt and dust are present to a greater degree, the depreciation may be 25 per cent in a month. Adequate data are available which prove that the depreciation of light output is so great that frequent cleaning pays dividends.

In places where the lighting equipment accumulates only dry dust and the soot from smoke, a wiping with a

dry cloth may serve fairly well between washings. The period between the latter then may be doubled. Owing to the extreme variety of conditions, it is difficult to give advice pertaining to the frequency of washings. Under very dirty conditions the period may be about one week. Under moderately dirty conditions this period may be doubled. Under average conditions, perhaps the equipment should be washed about once each month. However, in offices and factories where the location may be designated as clean, the period between washings perhaps should not exceed two months.

The painted surfaces of ceiling, walls, and certain parts of machinery also need maintenance if the lighting installation is to be kept at its highest efficiency. In the August, 1926, issue of INDUSTRIAL ENGINEERING lighting value of paint was discussed and an attempt was made to show when these surfaces should be renewed. It was also shown that the painting could be done with the money saved through the increased intensity of illumination resulting therefrom.

Cleaning compounds are available for the more difficult cases of windows and skylights in factories. However, such extreme conditions are seldom encountered in the maintenance of artificial lighting equipment so that soap and water are usually satisfactory.

Most electric filament lamps are still designed for a 1,000-hr. life. This is a matter of tradition because the present cost of light justifies a shorter life. Lamps account for only a few per cent of the cost of lighting; therefore, it is false economy to let them remain in the sockets after their normal life has been lived. Although blackening of the bulbs is not a serious factor any more, it still absorbs an appreciable amount of light after the 1,000-hr. period has been reached. As a matter of safety the lamps of creditable manufacturers are designed for a slightly longer life than the guaranteed average. For this reason about 25 per cent of the lamps should be operating at the end of 1,200 hr. If these are appreciably blackened it pays to replace them.

Furthermore, the lamps are designed for a certain voltage and the light output decreases rapidly as the voltage decreases. For example, if the voltage at the socket is only 95 per cent of that for which the lamp is designed, the output of light is reduced to 83 per cent of its value at normal voltage. This loss of 17 per cent of the light is achieved at a saving of only 8 per cent of the energy consumption. Certainly this does not pay. Under this condition of line voltage, 5 volts less than it should be, it takes 6 lamps to give as much light as 5 lamps would if the proper voltage were available at the socket.

THE SAME FACTORY AFTER THE INSTALLATION OF AN APPROVED LIGHTING SYSTEM and the renewal of painted surfaces. Now systematic maintenance keeps this lighting system efficient and up-to-date, which is a natural result of such an activity.

* * * *

Obviously, it pays to give attention to the lamps aside from cleaning them along with the lighting unit. Maintenance should include replacing burned-out lamps, inspection of those which have been in operation a long time, and voltage surveys along the lines, which results in obtaining lamps of proper voltage. This is a very important point which is often neglected at the expense of good lighting. The user does not obtain the light he pays for, unless these factors are given the careful attention that they deserve.

Even though the proper combination of lamps, reflectors, glassware, etc., is incorporated in the lighting units when initially installed, this combination is not always adhered to afterward. In open metal reflectors or glass shades, bowl-enameled or all-frosted lamps may have been installed originally. Through carelessness or for some other reason, clear-bulb lamps may later be substituted. Perhaps the foreman or workman desires more light and obtains it by using a larger lamp. Such changes often result in glare directly from the lamps as shown by the accompanying illustrations, or from polished metal surfaces which reflect images of the bright light-sources. Usually such improper combinations also result in decreased efficiency of the lighting equipment. Maintenance of lighting systems should include these factors even to the replacement of the reflectors or glassware, if necessary. Likewise, attention should be given to localized units used on machines or over certain work-spaces to supplement the general lighting. They are more or less subject to control by the worker and, therefore, are often improperly used, not only at the expense of efficiency and that particular worker's ability to see well, but also at the expense of the vision of nearby workers. Somewhere—perhaps on the lighting-unit itself—a record should be made of the proper type and size of lamp to be used.

Besides the usual equipment for cleaning the lighting units, ingenuity can invent others. Perhaps two men may work together more efficiently than one. If the reflector or glassware is removed a spare one is often desirable. The dirty one may be lowered and a clean one installed by the man on the ladder while the man on the floor is cleaning the dirty one. If the entire unit can be unhooked it is seen that this system is quite satisfactory. These details are readily worked out by those responsible for

maintenance, who should know that proper planning and proper tools expedite matters.

There are two devices which might not be thought of, although they are essential to the proper maintenance of lighting systems. A voltmeter is necessary to check up the voltage at the sockets and to make certain that lamps of proper voltage are used. The standard voltages of electric filament lamps in this country are 110, 115, and 120. At the present time nearly 60 per cent of all the large lamps are of the 115-volt type.

Another important tool is a portable photometer so that intensities of illumination can be studied and recorded. Several of these are available. The simplest is a foot-candle meter which is also quite inexpensive. With such a device the maintenance executive is able to come to conclusions in regard to the adequacy of illumination and the effect of maintenance upon intensity of illumination. Of course, the final measure of lighting is the ability to see quickly, accurately, safely and comfortably, but even the most expert lighting specialist depends primarily upon actual measurements of foot-candles. Certainly, the less expert, such as maintenance engineers, cannot depend solely upon visual inspection and their unsupported estimate and judgment. Measuring devices of all kinds are in use in industry. Why should lighting, important as it is, be unmeasured? Of course, the measurement of foot-candles alone does not give a complete appraisal of a lighting installation. This is only a measure of the quantity of light at a certain work-plane. As such, it is very useful and it is a measurement which can be easily made and which is very fundamental.

Without records memory must be relied upon. Systematic maintenance at regular intervals may not require actual record-keeping. Without either, the maintenance degenerates into guesswork. In this, as in other industrial operations, unnecessary red tape is sheer waste. The best system is one which is so regulated and planned as to be simple and foolproof. Those in charge of maintenance can readily devise their own system particularly adapted to their needs. If records are to be kept they may include any or all of the important factors. They might include the date of cleaning of the lighting units, the date of replacement of lamps, and foot-candle readings at definite stations several times a year or even every week or two. The periodicity of cleaning and other factors will be determined by study which should reveal the direct profits and to some extent the indirect profits. Why lighting systems should be maintained, is readily answered in all cases. The questions, *how* and *when* are partially answered in the foregoing, but the remainder of the answers must be supplied by those responsible for the equipment and operation of specific industrial plants.

Maintenance of Elevator Switchboards

THE AMOUNT of care an elevator switchboard requires depends to a great extent on the kind of service the elevator performs and how its operation is managed.

Heavy-duty freight elevators not having leveling devices, have a greater wear and tear on their switchboards than those performing lighter freight or passenger duty, or wherever the automatic leveling device is employed.

Of elevators not equipped for automatic leveling, the passenger conveyance is the more economical on contact wear, for stopping the car within 4 or 5 in. of the landing, the "Watch you step" caution from the operator is sufficient for the safe ingress and egress of his passengers.

On the other hand, freight elevators whose freight consists of loads mounted on portable platforms which are loaded and unloaded from the elevator by means of machine trucks, require a level landing for the handling of their freight. And sometimes this means that either of the two reversing switches must necessarily be closed-in several times so as to bring the elevator to a level with the landing. Switchboards of such elevators, will of course, be harder on contacts and general wear.

On the switchboards of light-duty freight elevators, it is customary to have the carbons that complete the circuits through the main switches firmly fixed to the board in suitable receptacles. The copper contacts on the switches are flexibly mounted with springs behind them. Very often these contacts become so misaligned that they wear unevenly. Then again, this same undesirable wear is occasioned when the diameter of the copper contact is greater than that of the corresponding carbon. The carbon must also wear unevenly.

A weekly change of contacts on reversing and field switches, a light sandpapering of the lower contacts of these same switches, all carbons and all other minor contacts, and a casual inspection of the switchboard will prove very satisfactory. This attention should be given to all elevator switchboards, passenger and freight, and should it become necessary to neglect either one for a two-week period, it should be the latter.

Each switchboard should be provided with a complete set of extra contacts, especially those contacts that are subjected to heavy wear, extra springs and insulators.

On the back of the contacts should be stamped the letter or number of the elevator to which they belong, because not infrequently too many of them are allotted to one elevator, and when an emergency change has to be made a waste of time becomes evident.

A thorough yearly overhauling of switchboards is suggested as a means of preventing many an unexpected breakdown. But unless one is quite familiar with the board, one should not attempt the undertaking, especially on an elaborate basis.

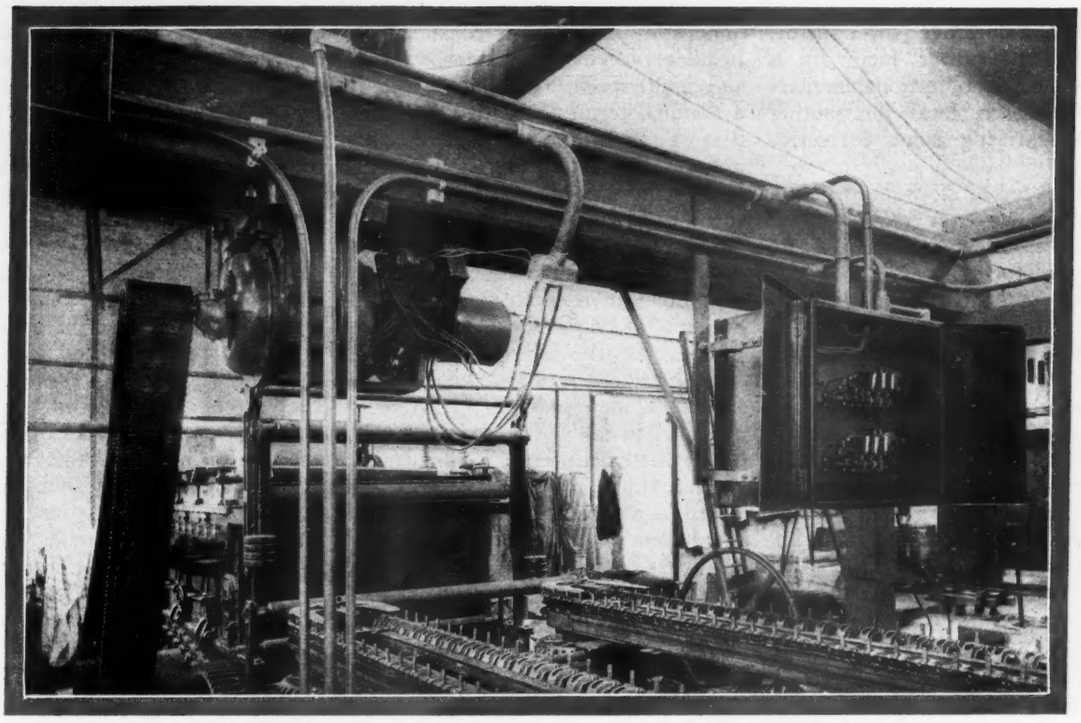
An overhauling would consist of: Taking off switches, wiping off plungers and cleaning out the cylinders of the holding-coil core with a kerosene-soaked rag; blowing back and front of board with compressed air or bellows; painting around insulators, iron parts and holding coils on front of board with a good grade of insulating compound; replacing badly worn axle pins, arc shields, pig tails and other connections; insulators, carbons, springs, etc. A light application of vaseline should be made on plungers of field, reversing and potential switches before replacement.

Examine back of board for loose nuts, and loose connections that may be occasioned by vibration. See that resistances are free from foreign metal articles that may cause short circuits. It is also advisable to make a note of the number of pieces of tools used at any time when working on a board, so that before the main switch is closed and the elevator started, there won't be any mishaps owing to a piece of tool remaining across a pair of contacts.

After work on a switchboard is completed, the workman should remain at the board until the elevator has made a few trial trips so that the functioning of the switches can be observed and adjustments made.

A. A. A. RODRIQUES.

New York, N. Y.



This adjustable-speed a.c. motor, with brush-shifting pilot motor, drives a mercerizing range

Replacing the MISFIT A.C. MOTORS

By R. H. ROGERS
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General Electric Company
Schenectady, N. Y.

ALTERNATING - CURRENT motors are manufactured in only a few fundamental types; however, there are many derived forms which, all together, present a wide variety of characteristics. Manufacturers naturally build only motors for which there is an extensive market, but there are numerous applications calling for all of these inherent or control-amplified combinations of characteristics. It is hoped to make this article helpful in the selection of the motors and control by presenting the characteristics of available motors in a practical way.

The best results are obtained when voltage and frequency are normal or nearly so. For successful operation, although the results will not necessarily be fully up to the standards established for normal conditions:

(*a*) The variation in voltage should not exceed 10 per cent above or below normal.

(*b*) The frequency variation should not exceed 5 per cent above or below normal.

(*c*) The sum of voltage and frequency variations should not exceed 10 per cent above or below normal, and the frequency variation should not exceed one-half of this sum.

The reasons for establishing these nominal limits are: Starting torque and maximum running torque vary as the square of the voltage; heating varies inversely with the square of the voltage; and the speed varies directly with the frequency. For example, a 220-volt motor on 15 per cent undervoltage will have less than three-fourths of its normal starting and maximum torque, and heating will be one-third greater.

Characteristics — Motor characteristics vary greatly in importance with different applications. It is well to determine which are of real and which of minor importance when selecting a motor, so that one's judgment will not be biased by perhaps unconsciously giving undue weight to really unimportant features.

Efficiency—The ratio of output to input energy is important in the case of large motors, particularly where they are in fairly constant use. The saving in power to be credited to a highly efficient unit may be capitalized and applied over a term of years to offset the lower cost of a less efficient motor, or used as a basis of comparison between two motors and their controls.

On the other hand, the efficiency of motors for intermittent use, or for a single installation of a small size, is unimportant in that it is very likely to be outweighed by other considerations.

Power Factor — The relative amount of magnetizing current required by a motor becomes important when the local distribution system is loaded well up to its capacity, where the voltage is affected, or where there is a premium in the power rate for high power factor. In conjunction

with units that improve power factor, reasonably low power factor in a motor is not so objectionable, particularly if each local distributing circuit is carrying some corrective apparatus.

Under-loaded or slow-speed induction motors are poor power factor units; hence, care should be taken to avoid overmotoring.

Torque—There are three torque conditions that need careful consideration: starting or break-away torque, accelerating torque, and maximum running torque. Full-load torque is a function of the normal horsepower rating of the motor; hence, it is the same for all types of motors of comparable horsepowers and speeds. The break-away torque is of prime importance for loads that are subject to high static friction, particularly after being shut down for some time. Many applications require very little starting torque; hence, this characteristic is of quite variable importance.

Accelerating torque measures the ability of the motor to bring its load up to full speed, once it has broken away from rest. Some loads build up very rapidly with increase in speeds; others fall off after the break-away. On some types of motors the torque drops when they are nearly up to speed. Care should, therefore, be taken to select a motor that will "pull in" the load that it has started.

Maximum running torque is the characteristic that determines the overload point at which the motor will pull out or stop. Loads subject to occasional heavy bumps should be motored to meet this condition. There are actually few cases where a motor properly chosen for normal running conditions is ever called upon to exert its maximum running torque, and there are many applications where no excessive overload is possible.

Speed—With respect to speed motors are classified as constant, adjustable, varying, adjustable-varying and multi-speed. Constant speed is a nominal term, for with the exception of synchronous motors, there is always a slip that varies with the load. Speed regulation from no-load to full-load is usually from 3 to 6 per cent. Adjustable speed at any point within the range does not vary with load more than by a nominal amount of slip, which usually increases as the speed is reduced. Varying speed means a wide regulation with load changes. It is often referred to as "series characteristic" from that feature of series-wound, d.c. motors.

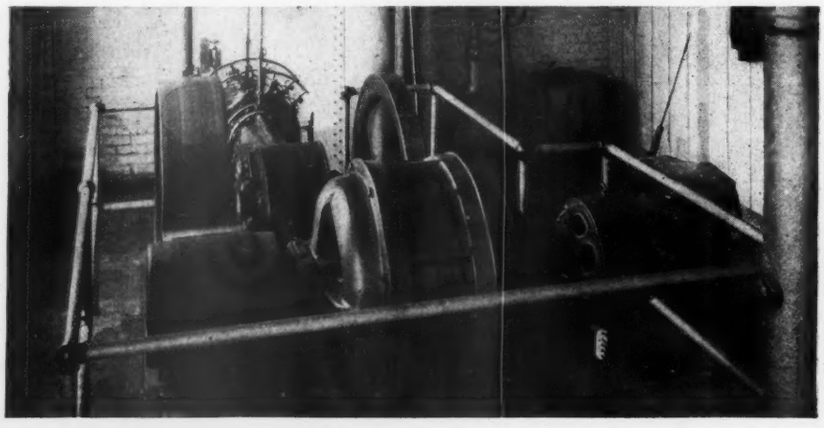
Adjustable-varying speed involves conditions whereby the speed can be adjusted for a given load, and then the speed changes as the load changes. Multi-speed motors may be operated at two, three, or four constant speeds which are definitely related, as 1,800 and 900, or 1,800, 1,200, 900, and 600 r. p. m.

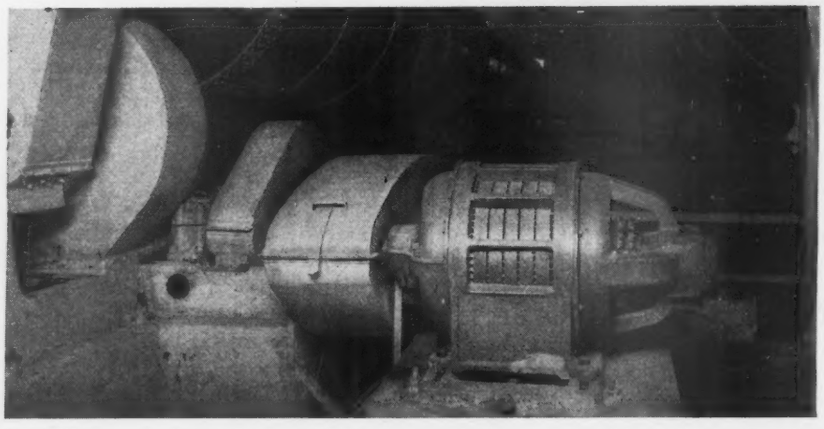
As stated under power factor, high-speed motors should be chosen, if it is feasible and economical to do so. Constant-speed motors meet the great majority of requirements. The precise speed of the synchronous motor is seldom required for practical work. Adjustable speed is indispensable on many jobs, but if a multi-speed motor will be satisfactory it and its control will be less expensive. Variable-speed characteristics tend to prevent overloading, particularly where the load goes up rapidly with the speed.

The actual speed requirements should be analyzed to avoid the purchase of over-expensive units, or the waste of power that in some cases goes with reduced speed.

Starting Current—The inrush of current at starting varies widely among the various types of motor, as the design influences the torque-per-ampere factor and also because the starting torque itself varies among the motor types. Furthermore, the starting current can be limited by the type of control used. Starting across the line allows the motor to take whatever current inrush that particular design requires. Reduced-voltage starting subdues the current inrush, but at the same time reduces the starting torque.

Local circumstances often govern the type of motor that can be used, by reason of starting current limitations. These limitations may be imposed by the public utility company or by conditions within the plant.





SYNCHRONOUS MOTORS are well adapted for driving air compressors and similar equipment. This general-purpose synchronous motor is rated at 75 hp., 900 r.p.m., .8 power factor. The exciter is direct-connected.

* * * *

A WOUND-ROTOR INDUCTION MOTOR driving a 250-ft. cement kiln. This motor is rated at 100 hp., 375/750 r.p.m., 440 volts, 25 cycles.

It is best to consider low-starting-current types, or the use of reduced voltage starters, or both, where starting current restrictions are found, although starting on full voltage is becoming the general practice with motors up to about 50-hp. rating.

Types of Motors—Commercial a.c. motors are designated as squirrel-cage induction, wound-rotor (or slip-ring) induction, synchronous, and commutator types. These types vary both in electrical and mechanical features. The electrical features will be treated in the discussion of each type of motor.

The mechanical forms available include: horizontal and vertical, several degrees of enclosure; various means of ventilation; several variations in bearings, bearing supports, shaft, and base, or the absence of some or all of these features.

Squirrel-Cage Induction Motor—This is the simplest form of commercial motor and deserves its position as a "best seller," for it fulfills the requirements in a great variety of industrial applications. Commercial lines include thousands of ratings when all horsepower ratings, speeds, voltages, cycles, etc., are considered.

The standard squirrel-cage motor of normal torque and normal reactance is characterized by a constant speed, medium starting torque, high starting current, efficiency about 90 per cent for 25 hp., high-speed sizes, and a power factor of .9 for similar ratings. A compensator may be required to reduce the starting current to that permitted by the power company. Some driven machines are complicated and require gradual application of starting torque which can be accomplished by using a resistance starter.

The normal-torque, high-reactance derivative is a popular, general-purpose, squirrel-cage motor having deep bars in the rotor. Compared with the parent motor, it has slightly greater starting torque, much lower starting current, about the same efficiency, and slightly lower power factor. In ratings up to 30 hp. these motors may be started on full voltage without exceeding the starting current recommendations of the N.E.L.A., which are very generally accepted. In many places the 40- and 50-hp. sizes are started on full voltage.

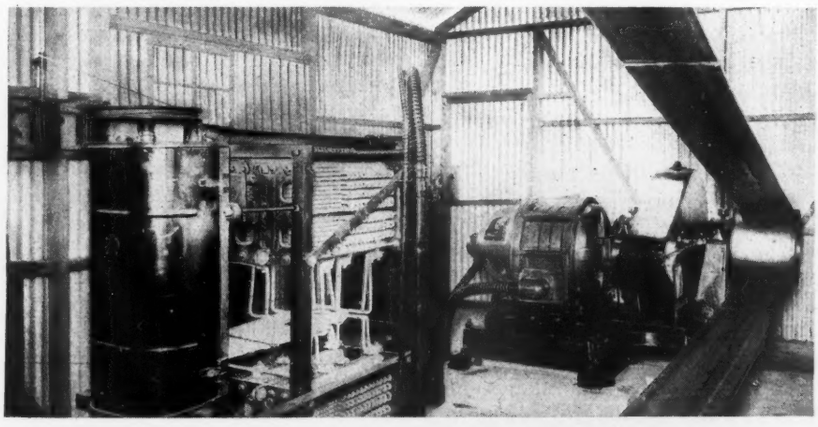
The high-torque, high-reactance derivative has two squirrel cages, both active all the time, but carrying different proportions of current when starting and when running. The automatic seeking of the preferred circuit serves to give very high starting torque on moderate starting current. This motor is started in the same manner as the previous one and within limits, is comparable to a wound-rotor (slip-ring) motor started with resistance inserted in the secondary circuit.

Obviously the control is much simpler than that required for the wound-rotor motor. The efficiency is comparable to, and the power factor is slightly less than, that of the parent motor.

The high-resistance rotor, squirrel-cage motor has very high starting torque and wide speed regulation or slip. It is well adapted for use with flywheels, its slip enabling it to get the most benefit from the flywheel. The torque per starting-current ampere is very high, and a line switch is commonly used with these motors.

Wound-Rotor Induction Motors—These motors are characterized by their inherent heavy starting torque and the gentle, steady application of this torque while resistance is being reduced in the secondary circuit. When used on constant-speed applications, a resistor is used that has a heat capacity designed only for the short starting period. If more or less resistance is left in the secondary circuit, the speed is adjustable-varying. The slip will depend upon the speed reduction becoming greater as the resistance is increased and the speed is decreased.

These motors are adapted for frequent, heavy-starting service, as most of the resultant heat is dissipated by the resistor away from the motor. Adjustable-speed work can be handled providing the rheostat losses are not too large, and the varying speed is a virtue, or at least is not too objectionable. With resistance all out the maximum torque is very high; hence, these motors will pull through a heavy overload.



A 35/15 HP., TWO-SPEED, WOUND-ROTOR INDUCTION MOTOR driving oil well equipment. The synchronous speeds are 1,200 and 600 r.p.m., and both speeds are variable.

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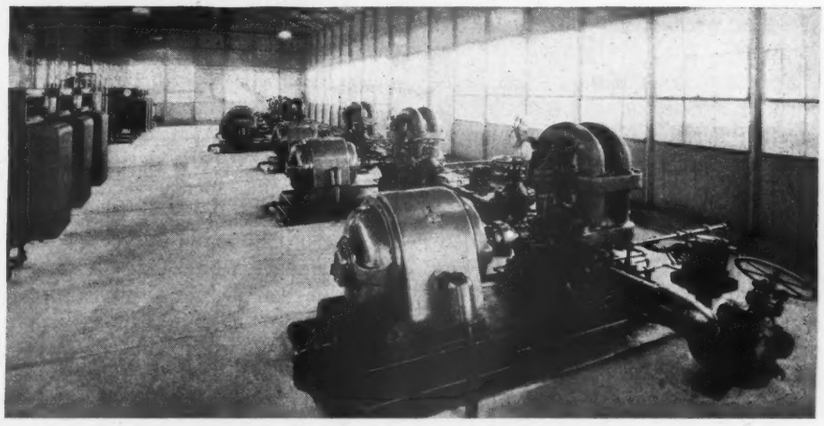


CHARACTERISTICS of squirrel-cage induction motors make them well adapted for driving centrifugal pumps. The 250-hp. motors shown here are equipped with ball bearings and operate at 3,600 r.p.m.

Multi-Speed Motors — A great many applications require two or more constant speeds, rather than need, adjustable speed. To meet these conditions at a lower cost than would be necessary for adjustable speeds, multi-speed motors are available. They can be obtained in either the squirrel-cage or wound-rotor types.

By means of taps in the windings and a pole-changing switch, 60-cycle squirrel-cage motors may be operated at 1,800 and 900, 1,200 and 600, or 900 and 450 r.p.m. with a single winding. With two windings the speeds may be 1,800, 1,200, 900, and 600, and other two-, three-, and four-speed combinations are available for all commercial frequencies. Each speed is constant and the change from one to another can be made while the motor is running.

Wound-rotor motors are also made multi-speed, usually in two speeds, and either or both may be constant or adjustable-varying as required.

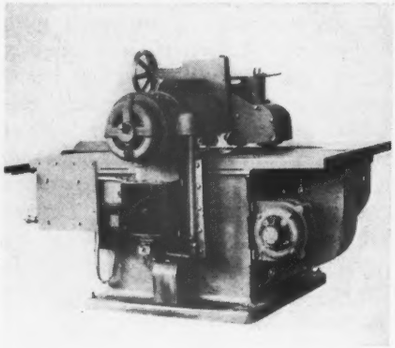
Commutator A.C. Motors — In order to obtain in some degree, the characteristics of shunt and series or compound-wound d.c. motors, a.c. motor designs that afford adjustable or varying-speed operation have been brought out. One type has the shunt characteristic; that is, its speed may be adjusted through a wide range although it maintains good speed regulation at all speeds. This motor is controlled by shifting its brushes either by hand or by means of a pilot motor.

The commutator a.c. motor having the series characteristic of wide speed regulation with changing loads is controlled by a transformer-tap-changing system.

At this point it might be well to state that the presence of an a.c. supply does not preclude the use of d.c. motors, as there are a great many instances where the superior characteristics of d.c. motors justify the cost of the necessary conversion apparatus.

Synchronous Motors — General-purpose synchronous motors closely paralleling the squirrel-cage type are now available in ratings from 20 hp. up. They are generally applicable wherever squirrel-cage motors can be used and, contrary to the general belief, their starting torque is high and they can pull into step any load that they can start. They may be had with or without a direct-connected exciter.

Synchronous motors are precise speed units; that is, they have no slip. However, this feature is of less importance than their ability to improve the power factor. Unity, .9 and .8 leading power factor units are available. They may be started manually or magnetically by compensators included with panels carrying the various equipment incident to protection and control of the d.c. excitation. Synchronous motors are especially useful on slow-speed applications where the power factor of an induction motor would be prohibitively low. The very high efficiency of



A CONSTANT-TORQUE, MULTI-SPEED FEED MOTOR (at the right) is used on this chain feed edger. The speeds available with this motor are 1,800, 1,200, 900 and 600 r.p.m. Undoubtedly there are many expensive, adjustable-speed motors being used where a two-, three-, or four-speed motor would answer as well and cost less.

* * * *

synchronous motors also makes them highly desirable for applications that require large, continuous-running units.

The selection of an electric motor and control for a given application depends upon the following factors: voltage, number of phases, frequency, and kind of system (two, three or four wire).

Modern motors are exceptionally well protected and insulated to withstand atmospheric and other conditions to which the majority of motors are subjected. For unusual conditions, however, manufacturers can furnish motors that have been especially designed to withstand the extraordinary conditions under which they will operate. If motors or controls are to be used under the following conditions, special recommendations should be secured: In the presence of inflammable gases or dusts, where a spark would cause an explosion; in rooms filled with hot or strong acid or alkaline vapors; where excessive moisture is present; where the room temperature is more than 40 deg. C. (104 deg. F) or below 0 deg. C. (32 deg. F); where windings are exposed to excessive amounts of conducting dusts, such as iron, carbon, or coke, or abrasive dusts, such as stone dust, cement, etc.; when subjected to occasional or repeated submergence, or to excessive vibration.

In many cases the user knows from past experience the type and rating of motor he wants, or the manufacturer of the machine to be driven frequently can supply the desired information. If it is not possible to get accurate information as to the size motor needed, the amount of power actually needed to start the load can usually be measured. As the frequency of starting, duration of the starting period, and unusual starting-current limitations are very vital factors in determining the type and size of control and motor, they should be determined. Otherwise, a generalization of starting conditions as light, medium heavy, or extremely heavy can surely be made. From this, an estimate as to the proper motor and control can be made. Where definite information as to the exact requirements is not available, it is advisable to test a motor out to see if it operates satisfactorily, before definitely selecting it for a particular job.

In general constant-speed motors are best in the vast majority of cases. Adjustable-speed motors are more expensive and in ordinary sizes are seldom justified unless the quantity or quality of the output of the driven machines will be improved, or the capacity will be materially increased.

Wide speed regulation is desirable with flywheel-type loads where the work strokes occur less than 25 times per minute, or where peak loads occur that might greatly overload the motor if it did not automatically slow down to take care of this condition.

Industrial power motors that are not especially designed and listed for specific power application are termed general-purpose motors.

The nameplates of general-purpose motors bear the statement, "Service factor 1.15 at rated volts and cycles."

As an example of the application of the service factor, assume a load that requires 55 hp. as a maximum. Instead of using a 60-hp. motor, a 50 hp. unit may be used as the service factor indicates a permissible loading of 50x1.15 or 57.4 hp., provided that the starting and maximum torques of the 50-hp. motor are sufficient and that the rated voltage and frequency are maintained.

Inspection . . . of PAINTED SURFACES

What it involves and its relation to plant maintenance

By ROY C. SHEELER

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Prescription Paint Service
E. I. du Pont de Nemours & Company
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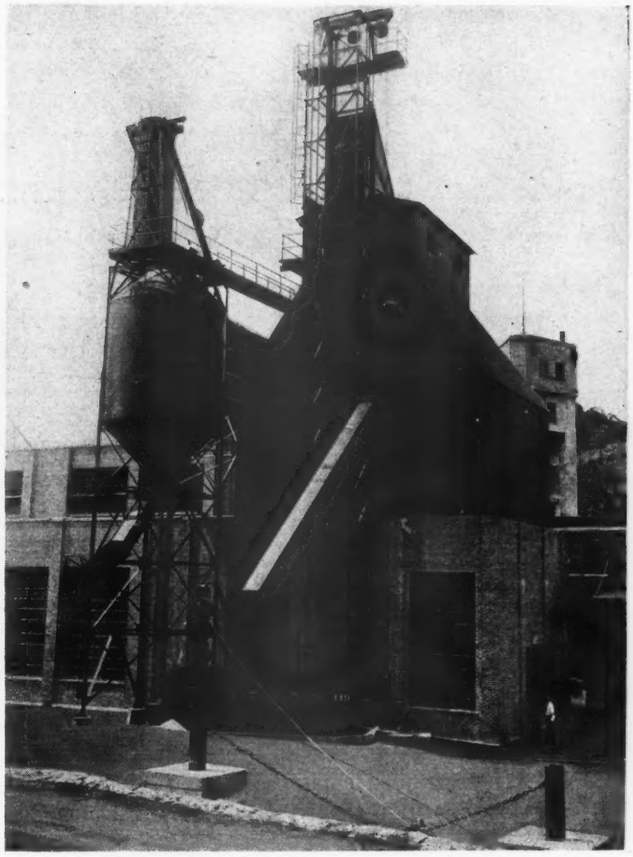


Weakening of such structures by rusting may result in serious accidents

EVERY one who has charge of electrical and other equipment knows the value of periodical inspection. They have found out, perhaps through sad experience, that it is poor policy to go ahead, month after month, without giving regular care to such equipment. Consequently, inspection and maintenance schedules are usually in force in every well-ordered plant.

This is not always the case as far as the physical condition of the plant buildings and structures is concerned. In far too many plants today there is no definite schedule covering the maintenance of them. What records there are, are not kept up to date nor taken very seriously. Metal, wood, concrete or brick surfaces are allowed to deteriorate to the point where expensive replacement becomes necessary. Too many plant superintendents and managers are trying to save money by postponing needed maintenance work. Or, when the work is to be done, they do not go deeply enough into the matter to be sure of obtaining the sort of protection the surfaces are entitled to.

A start in the right direction is a thorough inspection of the *present* condition of all surfaces, inside and outside the plant. In making this inspection, there are several things to look for.

First, find what records are available covering the date each surface was painted, and the kind and type of paint used. If there are no definite records, probably one of the workmen can give some information regarding it. This will enable you to make a check-up on the behaviour of the paint film. One of the most important objects of such an inspection is to discover both the good and the bad in paint application. There can be no definite method of determining the life of a paint coat, as it depends upon such factors as:

(*a*) Condition of the surface when the last painting was done.

(*b*) Proper preparation of the surface for painting.

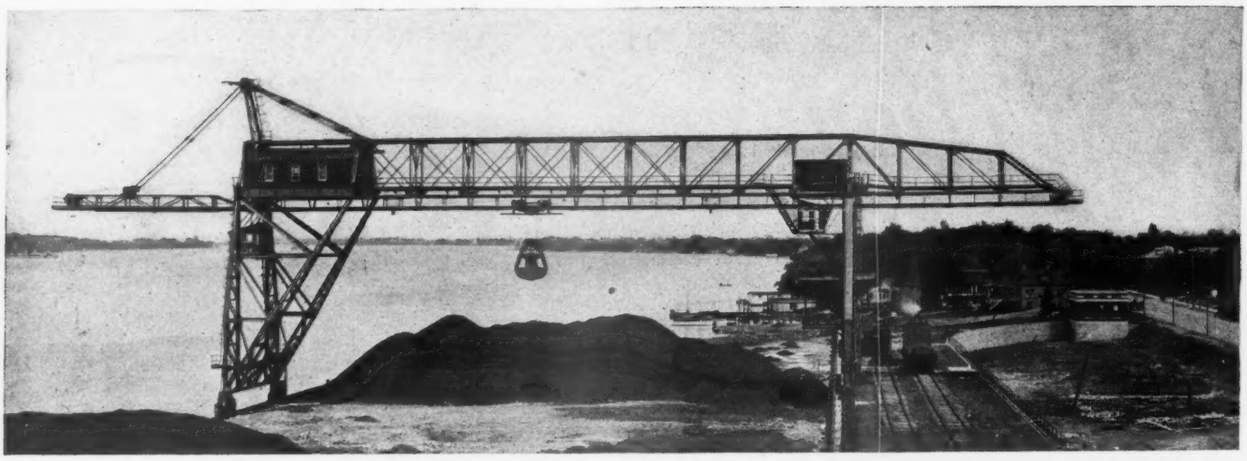
(*c*) Manner in which the paint was applied.

(*d*) Atmospheric conditions under which the paint must serve.

Under certain conditions a paint coat may be good for three to five years, whereas in another plant, it would not stand up for six months. Therefore, when making the inspection, all unusual or severe conditions under which the paint must serve should be borne in mind. This point will be discussed later.

A paint inspection should be thorough, and starting with the outside of the plant, should include roofs, siding, window frames and sash, fences and gates, bridges and passageways, doors, tanks and their supports, gutter, spouting and rain conductors, fire escapes and ladders, pipe lines, covered and uncovered, fire plugs, hydrants, alarm boxes, hose carriages, stacks and similar exterior surfaces, ventilators, and all other exposed surfaces subject to deterioration.

Inspections should show the condition of these surfaces, first, from the standpoint of general appearance. The appearance of a plant has a great deal to do with profits. An untidy, run-down-at-the-heels plant has a bad effect upon the workmen. They are likely to become careless in their work and have no incentive for keeping the plant in a healthy condition. On the other hand, management that cares for the physical appearance of the plant and does everything possible to add to its attractive-



PAINT IS THE ONLY THING that will protect steel and iron work like this from rust.

* * * *

ness is usually rewarded with a better class of workmen and better quality workmanship.

Following this there should be a very thorough study of the amount of deterioration that has taken place. This is supremely important from the dollars-and-cents standpoint. Let us check over the surfaces mentioned previously and see exactly what to look for.

Roofs—These vary widely in character. Composition roofs become brittle, lifeless, and porous. Small cracks may lead to big leaks and, unless action is taken, may lead to expensive replacement. Metal roofs rust. Shingle roofs become "fuzzy" and defective. Even tile becomes pitted and defective under certain industrial conditions. Proper treatment will in many instances save costly replacement. But it must be done in time.

Siding—Here one must look for a worn-out coat of paint, for excessive chalking and fading of color, for cracking of the wood surface, allowing moisture to penetrate, and for general decay and rot.

Window Frames and Sash—These surfaces are especially susceptible to the conditions described in the preceding paragraph. The exposed sill is usually the surface that goes first. It offers a good lodging place for those things which cause a paint coat to deteriorate.

Fences and Gates—Metal fences are very easy to pass by; however, rust has a bad habit of attacking things that are often overlooked. As a consequence, unless kept well painted the time will come when the supposedly good fence has outlived its usefulness.

Wood fences and gates are frequently neglected, and although from a protection standpoint they may be capable of giving good service, they are hardly a credit to the good housekeeping of the plant engineer.

Bridges and Passageways — Look for rust and decay at the important spots. An overload at some particular point might prove fatal. Rot in wood structures is equally dangerous.

Doors—Appearance is often an important factor on these parts. They may be fire doors, supposed to be kept a brilliant red or yellow. If faded out and scuffed, they fail to serve their purpose. Check up the appearance of the handmarks. Renewing these is sometimes all that is necessary.

Tanks and Supports—With the life of the property depending upon the contents of the tank, in case of fire, it is supremely important to keep a careful check upon its condition. Rot in wood and rust on metal can do a vast amount of damage here.

Gutters and Spouts—Leaks in this equipment not only destroy its effectiveness, but at the same time may seriously damage adjacent surfaces.

Fire Escapes and Ladders—It should not be necessary to stress the importance of rust prevention on these structures. Once you let rust gain headway here, it means trouble and expense.

Pipe Lines—Small leaks in these may lead to big leaks in power and efficiency. Look at the joints, especially, for that is where trouble is most likely to start.

Fire Plugs and Hydrants — The main point here is brilliance of color or easy visibility at night. Dingy, fading colors are not an asset in the conduct of any plant and are especially objectionable on fire fighting equipment.

Stacks—These and similar structures are expensive in first cost. Rust is the beginning of trouble and should be prevented by adequate protection of the surface.

Ventilators—These are attacked by condensation, which lodges in crevices that are often unseen. It pays to look this equipment over very carefully.

The foregoing covers the general run of exterior surfaces about a plant, and the points to check up on each. Frequently there are conditions peculiar to certain plants that must have special consideration.

The inspection of plant interiors should be made along somewhat different lines. All surfaces should be inspected to detect decay and corrosion, and also from the standpoint of light reflection and general appearance. Interior surfaces become soiled and dingy, although so gradually that one is hardly conscious of it. This condition very materially affects the light-reflecting value of all surfaces, causing eye-strain, imperfect work, and accidents. In the average plant, the following surfaces should be considered.

Ceilings—Of first importance is the whiteness or light-reflecting quality of such surfaces. Manufacturing operations may considerably affect their efficiency in this respect. Frequently oils and grease from the floor above penetrate through the floor, badly staining the ceiling beneath. Such conditions should be corrected at the source, whenever possible to do so. This will permit treatment of the underneath surface to restore its light-reflecting qualities. Also, examine the condition of the steel supporting joists and beams to see that these have not rusted at any important point.

Walls—Upper walls are exposed to about the same conditions as ceiling surfaces. It is equally important that their light-reflecting efficiency be

maintained. Lower walls, up to about 5 ft. in height, are likely to show the result of physical contact and become soiled and dirty. Check them up from the standpoint of cleanliness.

Floors—These often constitute a real problem. Even the best of floors, laid in the most painstaking manner, will not stand up under the punishment they receive through trucking and other operations. Disintegration and wear on concrete floors are almost impossible to prevent in many plants. The inspection should bring to light any sections that are likely to cause accidents, or interfere with the manufacturing schedules.

Painting these surfaces will in many cases add greatly to their life and efficiency. Look especially at corners for accumulations of dirt and dust. The practice of painting corners white is a splendid plan for improving housekeeping methods. In the case of metal floors about the only thing to watch for are evidences of rust, which may weaken their strength and resistance to hard wear.

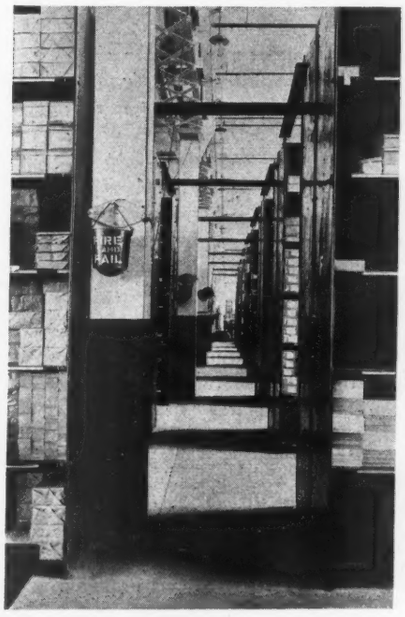
Doors and Door Frames—In modern plant a dark-colored or black handmark is provided around the knobs of doors, in order to prevent rapid soiling of the surface. The general appearance of these surfaces should be carefully checked up.

Elevator Gates and Shafts—Quick visibility for accident prevention is the important point here. A vivid yellow or red color is a necessity. A dingy, dirty surface looses its effectiveness as a danger sign.

Machinery — Modern plants are rapidly changing the color of their machinery as much as possible from the drab, dark colors to light grey, aluminum and the like. This practice adds much to the appearance of the interior, leads operators to take better care of their equipment, and do better work, and lessens eye-strain.

Conduits and Switch Boxes—For the most part little trouble is experienced with conduits. Switch boxes should, however, be prominently marked for quick visibility. Painting them a bright yellow, orange, or red is good practice.

Sprinkler and Piping Systems—Leakage from rust, especially at joints, is the main problem here. In plants having intricate piping systems, proper identification is essential. It is important that the scheme of color marking be followed correctly and the lines kept bright.



WHITE CEILINGS AND UPPER WALLS, with a dark dado below, make an ideal combination. Note how clearly the red fire pails stand out against the white background. Easy visibility of firefighting equipment is a very important consideration.

Firefighting Equipment — When such apparatus is needed, it is wanted quickly. It should, therefore, have a distinctive color, such as yellow, orange, or red.

Cranes and Hooks—Safety and visibility are of prime importance here. This applies especially to the sheave and hook units, which are suspended in the air. Unless distinguished as a bright spot of color, they may not be noticed when descending and so cause accident or injury to employees.

There are many other interior surfaces, an inspection of which will usually show the need of paint protection, or at least bring to light those surfaces that do need attention. When a new schedule of painting goes into effect, a careful record should be kept of the following data:

Date painting is done.
Kind and amount of material used.
Hours of labor.
Cost of labor.
Cost of material.

A record such as this, faithfully kept over a period of years, constitutes a very valuable source of information. It will clearly show the manner in which the various products stand up in your plant and how much each piece of work cost in labor and material. It will give you a picture of one of your main maintenance problems from which the paint manufacturer can determine what improvements can be made in the selection of materials when painting is to be done again. Furthermore, such a record places maintenance painting upon an engineering basis, by taking it out of the hit-or-miss classification into which it is likely to fall.

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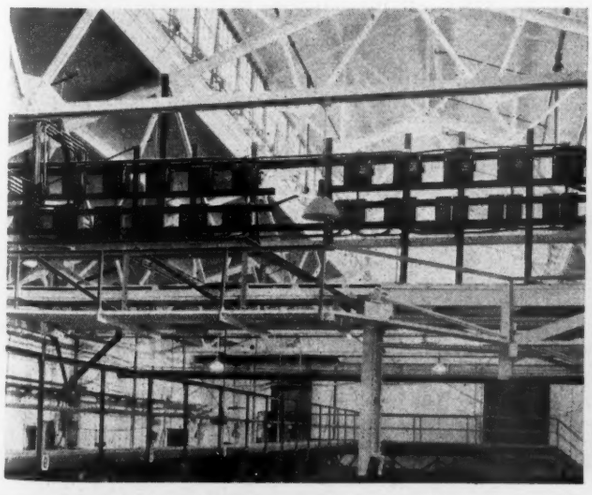
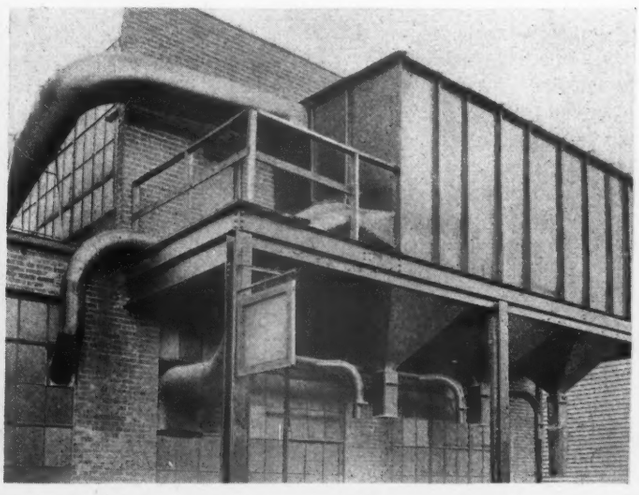
STEEL WORK THAT IS KEPT WELL PAINTED looks better and will last indefinitely.





LIGHT SHEET METAL WORK MUST BE PROTECTED from the weather.

On machines like this, reactionary pressure on certain bearings must be considered when selecting the lubricant

Points to keep in mind when

Selecting LUBRICANTS *for New Equipment*

By ALLEN F. BREWER
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The Texas Company, New York, N. Y.

LUBRICATION is one of the most important details in the maintenance of new machinery installations, for upon this factor depends the protection of the wearing elements. And yet there are many who will unhesitatingly put a considerable amount of capital into an intricate piece of equipment that has been designed for accurate production, and then serve its bearings, gears, and chains with oils or greases, regardless of their suitability.

Without doubt such a procedure is the cause of much machine trouble, and creates an impression on the part of certain operators that the equipment involved is incapable of meeting its guarantee, through faulty design or construction.

As a general rule there will be certain definite lubricating requirements involved in the operation of almost any piece of machinery. These will depend upon:

1. Nature of the duty involved.
2. Type of product to be handled.
3. The operating speed.
4. Reactionary pressures on the wearing elements.
5. Prevailing temperatures of operation.
6. Extent to which automatic lubrication is employed.
7. Manner of guarding or protecting gears or chains.
8. Degree of cleanliness that can be maintained.

Each of these must be considered from the viewpoint of its bearing upon subsequent efficiency of operation. Where new machinery is involved a most careful analysis should be made. Builders of industrial equipment today are putting their best efforts into the development of equipment that will be capable of extreme accuracy and a maximum rate of production. Whether these will long be maintained will depend upon

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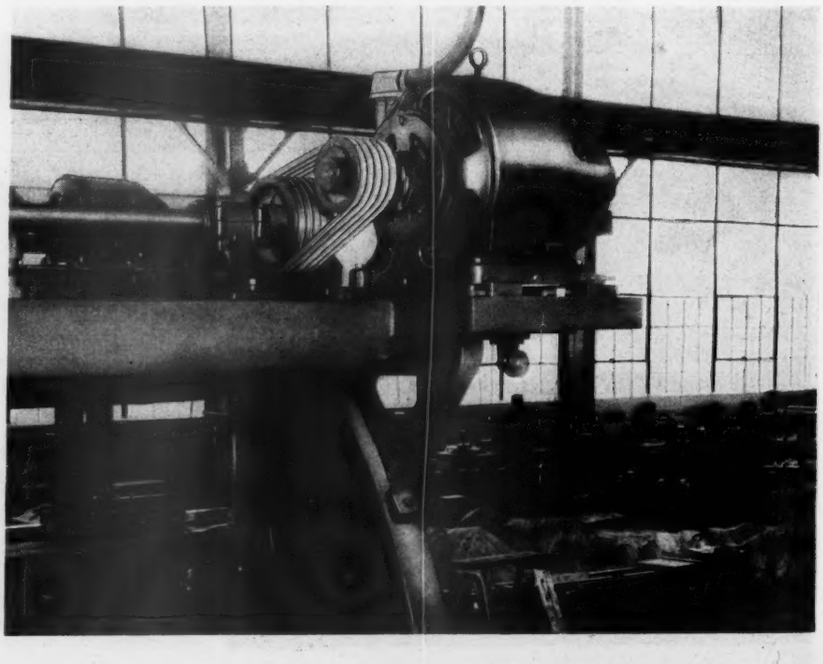
LUBRICANTS FOR MACHINE TOOLS must be chosen in accordance with the duty requirements. In many instances the possibility of contamination by metallic chips and dirt makes it difficult to maintain effective lubrication. Care in the selection of the oil or grease lubricants will make this problem easier to solve.



how effectively the wearing parts are lubricated.

In this connection, there are certain basic characteristics of lubricants that must be understood. They are the means whereby one lubricating oil, for example, can be differentiated from another; in many instances they will be guides as to the ability of any specific product to meet the obvious operating requirements. In general, the viscosity or relative fluidity, the pour test or temperature of congealment, the carbon residue content, and the flash point will be of primary interest.

To afford the clearest understanding of their bearing on the problem it will be well to discuss them in connection with the several operating factors mentioned above. Consider, for example, the duty to be performed. The equipment may be a textile loom, say, or a rolling mill in the steel industry. Obviously, there is no contrast in regard to the duty required, except possibly from the viewpoint of accuracy.

The loom is a high-speed machine; it involves a multitude of intricate mechanisms and the products handled are of a highly perishable character. Lubricants for such equipment must be of the highest degree of refinement; they must show as little tendency as possible to stain the goods in case they should drip or splash on them, and they must have adequate body or viscosity to maintain proper lubricating films on all wearing elements, for wear will promote inaccuracy. And yet, too high a viscosity will in many cases lead to abnormal drag and power consumption. In reality, the loom, especially when new, presents a real problem in the selection of suitable lubricants, for upon their suitability will depend the life and productive ability of the machine, and the quality of the woven products.

The rolling mill, on the other hand, is massive, the bearings are subject to high reaction pressures and to comparatively high temperatures and usually operate in an atmosphere of dust, dirt, flying scale, slag, and perhaps moisture. Yet it must roll steel bars, billets, shapes, or plates to a relatively high degree of accuracy. Speed conditions, however, range from comparatively low to medium.

In the lubrication of the gears, pinions, and bearings of the rolling mill the outstanding characteristics of the lubricants must be viscosity and adhesive ability. Such parts are very accurately designed, and even though large, must function in absolute accord with each other. Only by effective lubrication can this be maintained. Should gear teeth become worn or bearings scored, chattering or pounding may occur; this, in turn, will lead not only to increased wear, but also to inaccuracies in rolling, high power consumption, and abnormal maintenance expense.

In the selection of lubricants for such service, the effects of heat, pressure, and foreign matter must always be considered. Heat will tend to thin down or render a lubricant more fluid; pressure will tend to squeeze it from between the wearing surfaces of gear teeth, or from bearings, and foreign matter will be absorbed, leading to scoring or abrasion of the surfaces with which it comes in contact.

Any lubricant that is chosen must meet *all* of these conditions. It is not enough to meet only one or two. So the problem in selecting a lubricant for the rolling mill resolves itself into a matter of ascertaining the probable operating viscosity at the temperatures and pressures of operation, and the degree to which the resultant lubricating film will resist contamination with foreign matter. Merely to look at such a product, or to rub it with the fingers is not enough. Proof of the actual ability of the lubricant to function under the prevailing conditions is essential. Frequently this proof is available in the form of test data and observations made under actual operating conditions. If not, tests should be made to determine the suitability of the material.

Mention has already been made of the importance of the product handled in discussing the lubrication of

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ONE LUBRICANT may have to serve under widely different conditions on the same machine. When a variety of speeds is employed, as on this wool-finishing gig, lubricants for the bearings must be carefully chosen, as sizes, pressures, and clearances may vary considerably. It is particularly important to protect new bearings while they are being run in.

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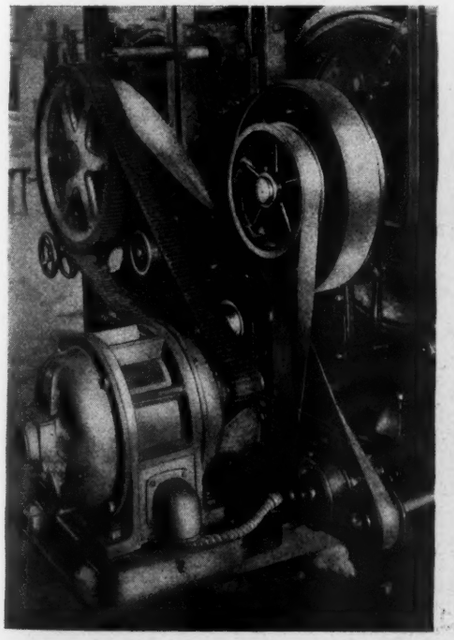
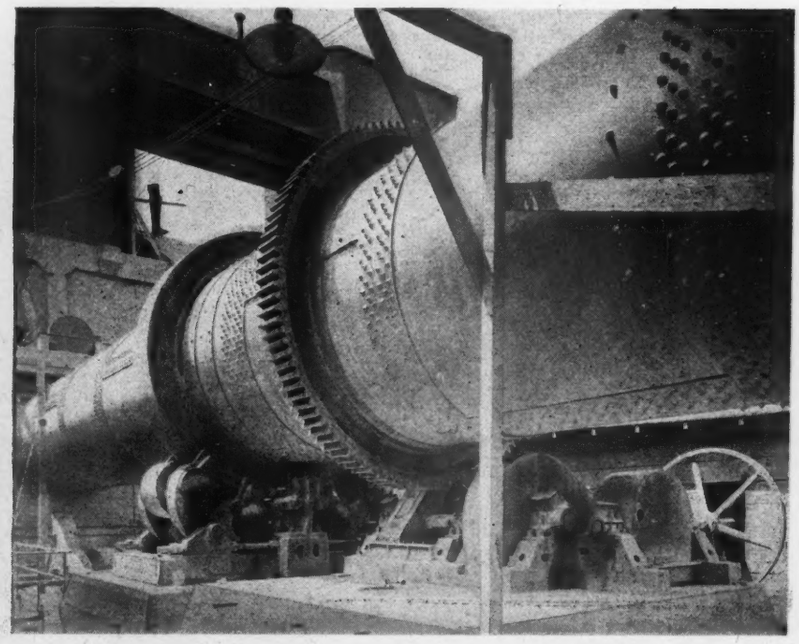
ABRASIVE DUST, with high temperature and bearing pressure must be counteracted by the lubricants. Lubrication of gearing on cement kilns and similar equipment is important, particularly in protecting it against premature wear. A highly-adhesive, straight mineral gear lubricant will effectively meet the requirements.





the loom. The textile industry does not stand alone, however, in this respect. Wherever machinery is used in connection with the production of foodstuffs, also, lubricants must be selected with especial regard to their purity.

In milling flour, for example, or making bread, it is obvious that every care must be taken to prevent lubricants from coming in contact with the products. True, they might not be seriously objectionable from a health point of view, but they certainly would impair the taste in many cases.

Proper selection of such products is, of course, important. Greases, especially, must be chosen with care, in view of the wide variety available and the extent to which improper compounding may impair the lubricating qualities.

Should separation occur, for example, oil might run prematurely through the bearings, leaving an accumulation of non-lubricating soap. If this is not forced completely out of the bearing on re-lubrication, oil grooves may become so clogged as to reduce lubrication to a dangerous extent. Meanwhile, as bearings overheat and perhaps become worn, many operators will be prone to blame the machine builder, in the belief that his design is imperfect. Of course, the product must be protected from contamination, but it is quite as important to protect costly machinery against wear. This can never be assured by haphazard buying of cheap lubricants.

The operating speed, in turn, is a factor wherever gearing, chains, or wire rope may be exposed or but imperfectly guarded. In this case the effects of centrifugal force must be considered. The surfaces of gear teeth or the connecting links of chain drives can be seriously damaged in a comparatively short time if they are not properly lubricated.

It is important to realize that centrifugal force will tend to throw off the lubricants from such parts. This tendency varies directly with the rotational speed, as a result, lubricants for such service must be highly adhesive in character, and capable of spreading uniformly over gear teeth and penetrating within the clearance spaces of chain connections. The higher the speed the more marked should be these qualifications.

In the selection of such lubricants for new equipment, the method of applying them must also be considered. Normally this will take the form of automatic circulation of oils, where the parts are completely encased; bath lubrication, whereby gear teeth or chain sprockets dip in a bath of oil in the base of the housing; or hand application of the lubricants.

Hand application normally requires the most careful consideration. In properly-housed installations centrifugal force may be virtually disregarded, for even if the oil is thrown off, it will drain back to the sump or reservoir. Hand application, however, is employed on most exposed parts, a straight mineral, semi-fluid, highly adhesive lubricant being used for gears, and a similar product, or grease, for driving chain connections.

Operating temperatures and reactionary pressures were referred in mentioning the rolling mill and its lubrication. It is fitting now to discuss them in detail. Both have a distinct bearing upon the selection of lubricants for new installations. In many instances the operating temperature of certain of the wearing elements cannot be forecast; it will depend to a certain extent upon the manner of housing, prevalence of drafts, the weather conditions, and even upon the body or viscosity of the lubricants used.

Reactionary pressures on bearings and gear teeth depend upon the nature of the materials to be handled. In pressing metal into various shapes, for example, the harder the metal and the thicker the sheets, the greater will be the pressure required. Naturally, this will affect the extent to which reactionary pressures will be exerted upon the various bearings and gears.

It is interesting to note that, from a lubrication point of view, the pressure that will be reacted back through the moving elements of the machine in question, as the dies,

(Please turn to page 136)

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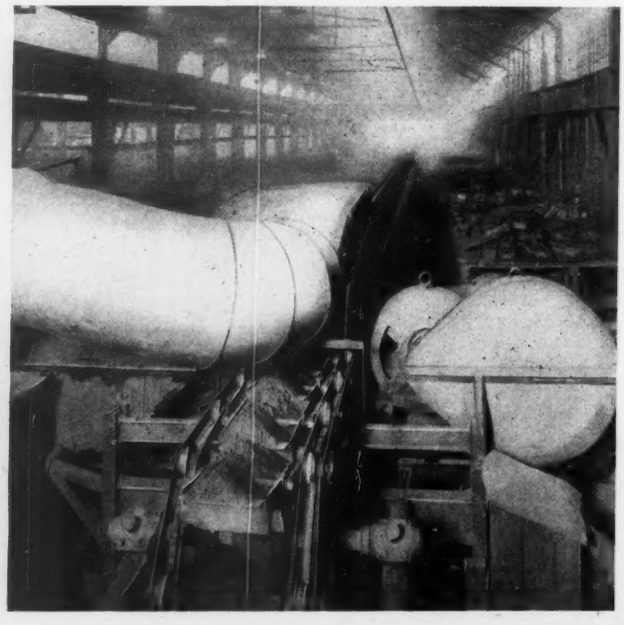
AUTOMATIC LUBRICATION by a force-feed oiler has many advantages. Note the oil pipes leading to the different bearings of this automobile spring machine. Not only are the bearings protected against wear, but there is little waste of lubricant, which means greater cleanliness.

THE PROBLEM HERE is to keep the bearings clean and well lubricated. This is a Peck carrier for handling prepared core sand in a steel foundry. On equipment for handling coal, sand, ore, and other abrasive material, a properly-designed lubricating system, the correct lubricant, and effective means of sealing the bearings will give long life in spite of the severe conditions.



BUILT-UP ROOFS will last several years if carefully laid

What Preparation for the UPKEEP of PLANT STRUCTURES?

"The high cost of new construction makes it advisable to keep all buildings in the best of condition in order to retard depreciation as much as possible."

Says W. G. ZEIGLER

THE maintenance of plant buildings and their fixed equipment constitutes a very important part of the work of the maintenance departments on account of the large investment in buildings. This work must be organized and systematically handled in order to safeguard the investment. Rust and decay start when the buildings are finished, and only by continuous care can the ravages of weather on the outside and wear on the inside be held in check, and the buildings be kept in perfect condition. The high cost of new construction makes it advisable to keep all buildings in the best of condition in order to retard depreciation as much as possible.

Exterior surfaces of buildings should be well painted to protect them against deterioration. Concrete surfaces that have not been waterproofed often absorb water that freezes in cold weather causing the surface to peel off. A good coat of concrete paint will prevent this trouble and preserve the concrete surface. This painting may be done by hand or by the spray method but in either case the surface should be dry and clean before painting so that the new paint will not blister.

Windows must be kept in good condition to prevent damage to goods by storms. Steel sash are very likely to rust unless they are kept well painted. Before painting all rust spots should be scraped and wire brushed down to the clean metal; these spots should be touched up before the whole surface is painted. Swinging sash must be kept weather tight to prevent excessive infiltration of cold air, as well as the entrance of rain and snow.

The catches should work correctly so that windows need not be slammed several times to make them stay shut. Swinging sash in monitors are controlled by sash-operating devices that must be kept in good working order so that a man can easily and quickly close the sash. The sash must be storm tight to prevent damage, and operating devices must close the sash tightly. Cracked or broken windows should be replaced promptly, and glazing compound put in wherever it has been knocked out.

Skylights should be very carefully caulked and all metal parts kept well painted because the metal in them is so thin that it rusts through very quickly. Skylights should be glazed with wire glass and have wire netting protection above them. Sidewall and monitor windows should be glazed with wire glass if the building is exposed to outside fire hazards, or if the building is of the fireproof type. Ribbed or prism glass throws the light to the center of the building and is, therefore, better than plain glass.

Clean windows are very important, and provisions should be made for regular cleaning.

The prevention of rust on fire escapes is very important in order that the weight-carrying capacity will not

be reduced. All rust spots should be carefully cleaned and a good steel protective coating applied. All swinging sections should be tried out regularly to be sure that they will operate correctly in an emergency.

Gravity and pressure sprinkler tanks are important units in the fire protection of a plant and they should be well taken care of. Wooden gravity tanks require painting every two or three years. Steel tanks should be painted every two years if they are exposed, and every three years when they are enclosed, as is the case with most pressure tanks.

Heating coils are usually placed in the bottom of exposed tanks to prevent the water from freezing, and steam risers should be run alongside the water pipe to keep it warm in cold weather. All exposed portions of steam and water pipes should be well covered with double-thick pipe covering to prevent freezing. The large main water pipe leading down from tank to sprinkler system is often housed in a double wooden box filled with insulating compound.

Where bridges connect buildings, steelwork that is exposed to the weather is kept from rusting by frequent painting. Rust will eat away the steel and make the bridge unsafe in time, and the cost of painting will be less than the loss due to rust caused by neglect. All rust spots must be thoroughly scraped down to the clean steel and wire-brushed to remove rust dust before painting, otherwise corrosion will go on under the new coat of paint. All corrugated iron used as covering should also be painted regularly. The deck of bridges is often of wood to lighten the dead load and a new deck or floor may be easily laid when the old one is badly worn.

Ventilators are often used to remove moist or corrosive vapors, in which case they are subjected to severe corrosion and they must be kept carefully coated with a protective paint, unless the material of which they are made is resistant to the effects of the vapor. Surfaces exposed to the weather must be kept painted.

A leaky roof should not be tolerated on a plant building because of the consequent damage to goods, machinery and equipment. Most new buildings have permanent roofs that are good for 20 to 30 years. On concrete buildings having a flat or nearly flat roof the roofings usually used are of the multi-layer paper type bound with tar or asphalt or are some of the asbestos or composition types of roofings.

Roofing paints with asphalt or gilsonite base are more expensive but last longer. All of these paints should be such that they will not crack when the roof expands with heat or contracts from cold. Cinder fills are usually used to pitch the roof so that water will not stand on it. Tin roofs are often encountered in the older plants and these require inspection and touching up rust spots every year, with a complete painting every two or three years. Slate roofs are rarely found on industrial plants because they are suitable only for steep sloped roofs; any cracked or broken slates should be replaced.

Flashings should be high enough above the roof to prevent melted snow or ice from getting above them and seeping through, and care should be taken to have a tight joint. Copper flashings are better than galvanized iron. Downspouts on new buildings are usually of cast iron or steel pipe inside the building while on older buildings downspouts are outside and subject to freezing in winter. One way to prevent this is to bleed a return steam line into the bottom of the downspout and thus keep it from freezing up. Downspouts should be fitted with strainers to prevent loose material from washing into them and clogging them up.

It is false economy to allow floors to become badly worn or rutted, because hand and electric trucks are slowed up and often forced to stop to pick up parts shaken off on account of the unevenness of the floor.

WOOD BLOCKS may be laid over old, worn-out concrete floors.

* * * *

Concrete floors are likely to dust and may be treated or hardened by sweeping with a water-soluble hardening compound, or they may be painted with a good concrete floor paint, containing a pigment, that will resist wear or be bound with a hard resin varnish having a gloss finish that is at once waterproof and wear resistant. On new concrete floors, hardening and waterproofing compounds may be mixed with the dry ingredients so that the finished floor will be hard and dustless.

For heavy loads or trucking the wood-block floors stand up very well.

* * * *

RUST QUICKLY DESTROYS STEEL SASH unless it is kept in good condition.

SANITARY washroom equipment is easily kept clean.

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These wood blocks are usually creosoted and in some cases they are furnished dovetailed to an understrip for ease in installation. Wooden floors of hard maple are often used and wear very well. These may be laid with tongue-and-grooved or square-edged boards. The latter are easier to replace when spots become worn but the tongue-and-grooved floors are usually used because the floor is a unit, and the edges of boards cannot spring up and, after scraping, the surface is smooth.

Clean, white walls and ceilings give the effect of cheerfulness and are bound to react favorably on the men. Both daylight and artificial lighting are also helped because white reflects practically all of the light falling on it. Better light means more production, less spoiled work and fewer accidents.

Many plants have found that oil paints are more economical in permanent buildings. These paints are often used in gloss or medium gloss finish for plants because the gloss finish is easily washed. A paint should be selected that will stay white under the conditions at each particular plant. There should be a regular schedule of painting so that the whole plant will be painted regularly. The time between painting depends on the work being done in the various departments, because some places require painting more often than others.

All surfaces should be dry and clean before painting; this is very important. Oily spots should be cleaned with benzine and coated with a waterproof sealer before painting. Stains may be prevented from coming through paint by putting on a coat or two of aluminum paint. Spray painting is being used more and more for interior painting. More material but less labor is required with this method than by the hand method.

Doors in firewalls must be fireproof and are usually of the tin-covered sliding type equipped with counterweights on a rope or cable that has a fusible link to release the weights and allow the door to run down an inclined rail in case of fire. Usually exits to stair towers and to the yard have swinging fire doors which are similarly equipped. These doors must be kept in good working condition to make sure that they will operate in case of fire. Elevator doors of the vertical raising and lowering types are subjected to hard jars due to trucks running over the lower door that forms a sill. They must be kept in good operating order so that they will not bind and delay the operation of the elevator.

All heating systems should be thoroughly gone over every summer or fall. All valves should be repacked and leaks in joints stopped up. The pipes should be lined up to prevent water hammer. Sprinkler systems must be kept in good condition at all times. Valves should be kept sealed, as directed by the insurance requirements, and sprinkler heads, where exposed to corrosion, should be renewed whenever they become corroded to prevent water damage due to a sprinkler head failing. All piping for water, gas, oil, air and other services should be painted in some manner to identify each service so that emergency repairs may be made quickly without tracing pipes. A standard set of colors should be selected and used throughout.

Elevators should be thoroughly inspected every day both as to mechanical and electrical parts and any emergency repairs made at once. Cables must be renewed when they become worn; this point is usually determined by the insurance inspectors. The car and counterweight guides should be lined up about once a year, especially if the elevator is subjected to the shock of heavily loaded trucks being run on it. The elevator machinery requires periodical oiling and greasing. The electrical contacts are subjected to very severe service on elevators that are used continuously and spare parts should be kept in the stockroom for all contacts and other parts that wear or burn out.

Outside of the actual advantages of proper maintenance of the plant from the standpoint of protecting the investment, there is the added advantage of the psychological effect of a well-kept plant on all the workers when they feel they are working in a plant where it is a matter of concern to the management that everything is taken care of, and the men are bound to have some of this same spirit instilled in them in their attitude towards their work, their tools and their machines.

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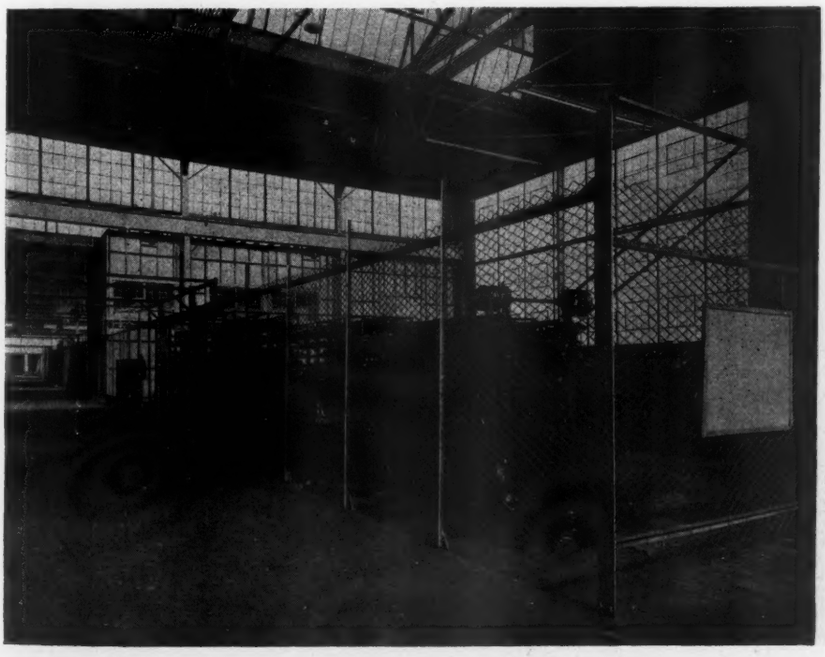
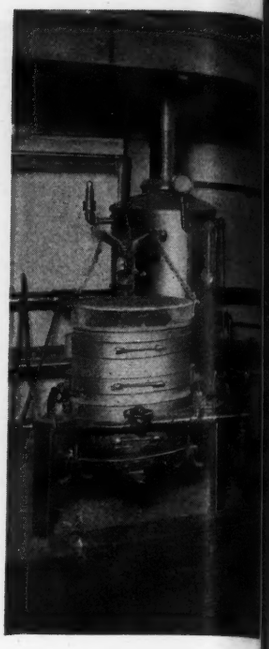
PARTITIONS OF EXPANDED METAL withstand much abuse.



Prevention or First Aid?
for the DISTRIBUTION SYSTEM



By F. A. WESTBROOK

MAINTENANCE and replacement of the electrical conductors for power and lighting purposes must to a very large extent be based on tests and the performance of the equipment supplied, rather than on visual inspection. This is because electrical wiring is usually hidden in conduit and, for obvious reasons, is always placed out of the way, where it is difficult to inspect. Furthermore, merely looking at a conductor really tells very little about its condition electrically.

On the other hand, testing with a Megger, say, is a very simple operation and will give a very accurate indication of the condition of the insulation. This could be done periodically to good advantage in most industrial plants, because by doing so actual breakdowns could be anticipated and lost time avoided.

However, when a weak spot is discovered in an electrical distribution line, either by actual failure or by tests that give a warning, it is not enough just to replace the section of conductor where the weakness exists. It should be replaced with the kind of wire, or insulated conductor, that will resist the conditions which caused the deterioration to take place. This sounds obvious and reasonable, of course, but the difficulty is that apparently many plant men do not realize that a great variety of wires and cables are on the market and that each has been designed for a specific purpose.

Before starting a discussion of these different types of conductors and the places where they should be used, let us first consider what are the agencies tending to cause early deterioration. First, there is mechanical injury before, during, and after installation. Then come continuous moisture, heating, either internal because the conductor is too small for its load or from external sources, direct sunlight, air and corona.

The existence of conditions such as these can usually be determined by inspection. When found to be present the proper kind of wire to resist them should be installed to replace that which has become defective.

Rubber insulation, which is used far more widely than any other kind in industrial electrification, is affected by all of these agencies. Mechanical injury during installation resulting in premature deterioration, is far more common than is ordinarily supposed. The wire should not be stepped on, nor should it be pulled too hard, because this tends to break down mechanically the very thin films of rubber around the particles of mineral filler used in all rubber insulating compounds. When this breaking down occurs air and moisture get into the insulating wall and electrical weakness soon develops.

Rubber being a vegetable substance, is subject to decay when in a damp place. Complete submersion in clean water does not affect it if the temperature is less than 65 or 70 deg. F., but more or less continuous dampness is sure to be fatal sooner or later. Keeping in water at a temperature above 70 deg. F., as may happen in a building that is kept warm during construction, or for drying out the plaster, will cause the rubber to absorb water and become useless as an electrical insulator.

Heat causes rubber insulation to

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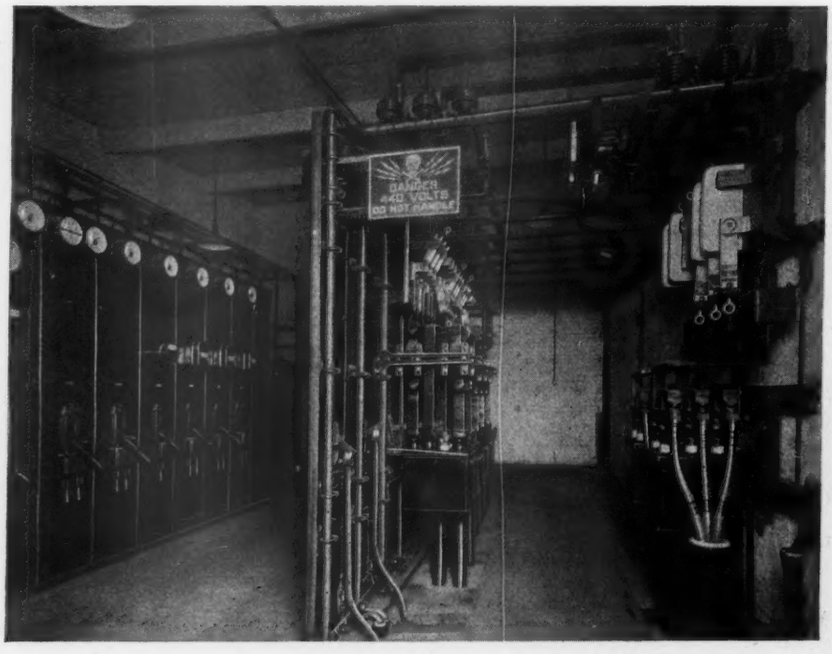
LEAD-COVERED CABLES with varnished cambric insulation are used in this installation for the underground run from the oil switches to the control boards for some large motors.



IN LOCATIONS LIKE THIS, rubber-covered wire must be protected from the heat. Rubber insulation deteriorates rapidly under temperatures that are appreciably higher than normal. Therefore, it is oftentimes advisable to use asbestos-covered conductors around furnaces, ovens, and similar equipment.

* * * *

age prematurely; that is, it becomes hard and brittle, which results in cracks when the wire is moved or jarred by the vibrations of machinery or otherwise.

Direct sunlight has very much the same effect as has an atmosphere highly charged with ozone.

The effect of corona is the same as that of ozone; in fact, the damage is caused by ozone formed by corona from the oxygen of the air. The presence of corona of sufficient intensity to cause failure of rubber-insulated wires and cables even at comparatively low voltages is not generally appreciated.

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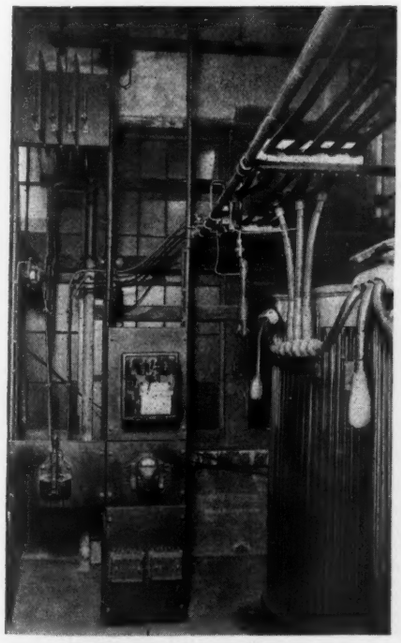
THESE TRANSFORMER LEADS are insulated with varnished cambric and covered with braid, to reduce injury hazards.



Consequently, when making an inspection of the plant wiring with a view to improving its condition and increasing the reliability of service, it is essential to give due consideration to the destructive effects of this agent. Corona exists around every charged electrical conductor, although it is not visible until the very high transmission voltages are reached. It is sufficient, however, to become a hazard at voltages above 1,000. Many cable failures that were first laid to poor insulation have been traced directly to this cause.

Corona causes premature aging, just as excessive heat and sunlight cause aging which results in the formation of cracks and general deterioration. If the rubber insulating compound is covered with a lead sheath the ozone formed by the corona is outside of the lead and cannot attack the rubber. If it is impracticable to use lead-covered sheathing, varnished-cambric insulation may be used. This is not affected by corona, and conductors on which it is used may be operated at a higher temperature, which means greater current density, than when rubber insulation is employed. Rubber-insulated cables, that are not lead covered, and that operate at 1,000 volts pressure or more should, therefore, be carefully watched, especially at bends where the first cracking occurs. Also, they should eventually be replaced with cables having a lead sheath, if rubber insulated, or with those having varnished-cambric insulation and a braided covering.

Some reliable manufacturers are now putting on the market a "corona-proof cable" which has a rubber insulation especially compounded to resist the action of ozone. This type gives very satisfactory service and is particularly useful in the smaller sizes, where varnished cambric cannot well be applied to the copper conductors, and where a lead covering over ordinary rubber compound would make the wire too stiff or heavy.

The above constitute the most important conditions to look for when plant inspections of wiring are made. Regardless of whether trouble has occurred at locations where any of the conditions mentioned exist, serious interruptions of production may be prevented by replacing existing wire of improper make-up with types that will withstand the unfavorable conditions. There are on the market wires and cables with insulation that is suitable for almost every condition likely to be found in an industrial plant, and the manufacturers are very willing to give expert advice.

If the wires are in a damp location they should be provided with lead sheaths. There is nothing else that can be depended upon to prevent eventual destruction of the insulation. Sometimes the action is slow and sometimes it is rapid, but the final result is inevitable. Impregnated, weatherproof braids afford little or no protection. Cases in which excessive dampness or moisture exist are by no means confined to underground conduits, which are always more or less wet. For instance, the plant inspection may show a conduit line directly over pickling vats from which clouds of steam are continually rising. Many cases are on record where such moisture has found its way into the conduit through a fixture or imperfectly sealed joint and has caused failure of the insulation.

In one case no end of trouble was experienced from moisture in the conduits in a packing house. Here some conduits passed from a room with a hot, moist atmosphere through a cooling room, with the result that condensation took place continuously in

the conduit and ordinary wires with braided coverings lasted only a short time. Replacing these with lead-covered wires cured the trouble.

Of course, the first cost of a lead-covered wire or cable is higher than for a braided covering, but with lead sheathing the life is of indefinite duration; so the annual charges are much reduced. Habitually damp locations for wires must be looked for and any wires that must be kept in such places might as well be replaced first as last with wires having lead sheaths, if that type has not already been installed.

There are two causes of heating of wires and cables—internal heating, due to the current carried, and external heating, due to proximity to steam pipes, flues, furnaces, and so forth. The existence of these conditions is easily determined by test and inspection.

The remedies are simple enough. If heating is due to the magnitude of the current, and if the circuit involved is a power circuit on which a small voltage drop makes no difference, as it would on a lighting circuit, the best thing to do is substitute a varnished-cambric-insulated conductor of the same size as the rubber-insulated conductor. Varnished cambric can stand much more heat than rubber. When it is a question of internal heating, therefore, the use of varnished-cambric insulation means less copper than if rubber insulation were used. Many of the most modern plants are now using varnished-cambric-insulated conductors for their power circuits.

When the heating occurs from external sources there are three ways of meeting the difficulty: (*a*) Move the wires or conduits away from the exposed situation. (*b*) If this is impracticable use varnished-cambric-insulated conductors if the heat is not too great. (*c*) Where very high temperatures are encountered, as in foundries or drop forging shops where piles of red hot metal parts are likely to accumulate under a feeder line, the only thing to do is use the so-called slow-burning wire. This usually has a covering of asbestos held in place with a braid saturated with a flameproof paint. This combination is, of course, unsuitable for damp locations.

Most successful plants in which there are hot places have learned by bitter experience how best to install the electrical circuits. Now that this experience is available for the use of all through the service departments of the best wire and cable manufacturers, there is no need of having troubles due to this cause. The best thing to do is make replacements before trouble occurs.

Sometimes a combination of heat and dampness occurs, although in such cases the heat is generally not so great as to call for the use of slow-burning wire. For example, it is frequently necessary to run conduit under the floor supporting a rolling mill. Here there is considerable heat, and there is also moisture from the water used to cool the rolls. One company which formerly had to replace rubber-insulated and braided wires in such a location about every ten months, solved the whole difficulty by using lead-covered, varnished-cambric-insulated conductors. The lead kept out the moisture, and the varnished cambric was not affected by the heat.

Wires and cables installed outdoors, that is, run aerially from building to building of an industrial plant, are subject to several trials of their own. Of course, wind and sleet storms are likely to bring them down. If they are of the rubber-insulated type they are subject to deterioration from the action of the sun and air, which cause premature aging and weathering.

Needless to say, this is a very undesirable method of installation. As a matter of fact, the old way of running feeders from roof to roof among the buildings of an nidustrial plant is a thing of the past, as it should be. It is most prevalent in old plants where electrification has come gradually and the only thing to do in such cases is for the electrical department to undertake to eliminate a part of such wiring every year, until it is all cleaned up.

The best way of transmitting power from one building to another is, of course, to run lead-covered cables in underground conduit from the main distributing switchboard to the distribution points in the various buildings. Sometimes, however, in very large plants, such as steel mills, high-tension, lead-covered cables supported on messenger wires suspended from poles are used instead of underground cables. This method has the advantage of saving the cost of a long stretch of underground conduit, and there are many instances where this type of construction is giving very satisfactory service. In one steel plant where such a cable passes under a coal pocket and is liable to damage from falling chunks of coal, the sheath is protected with helically-wound, galvanized-steel armor wires, as is done in the case of submarine cables.

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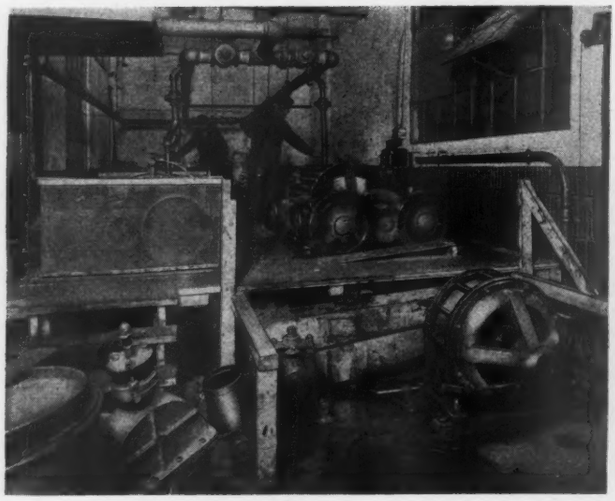
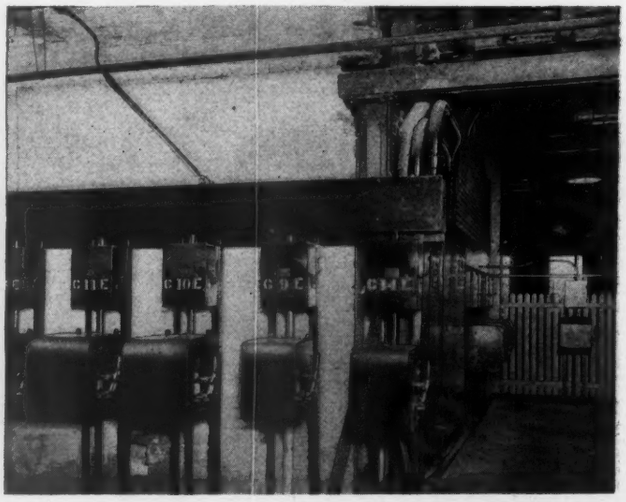
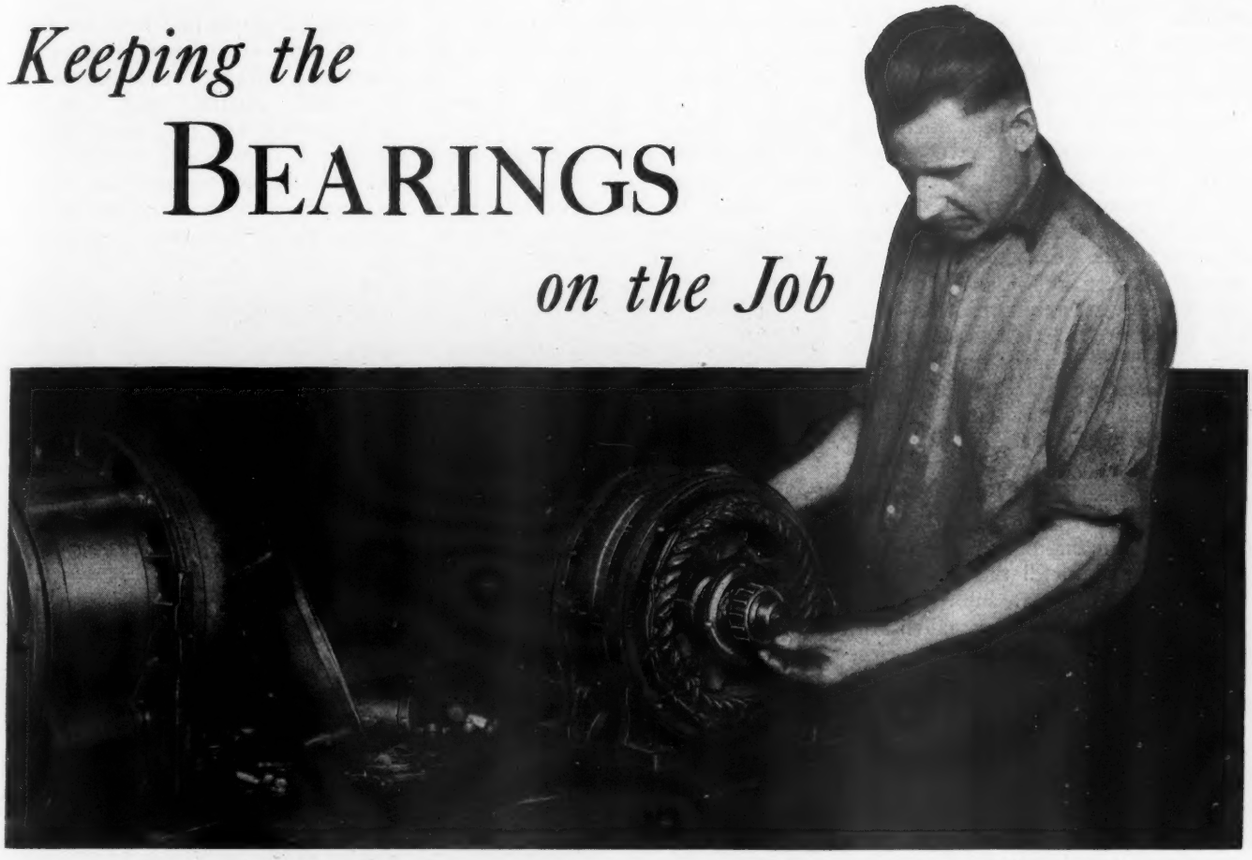
IN WET PLACES, watch out for trouble with rubber insulated wires in conduit. The conduit carrying the motor feeders is mounted on the wall and leads downward to avoid water on the floor.



INSULATION ON CONDUCTORS in this installation was chosen to meet conditions. The wires leading into these switches and starters for 440-volt motors are rubber-insulated and covered with braid.



Keeping the BEARINGS *on the Job*



The motor is in the repair shop for general overhauling, so the bearings are being carefully checked for defects before re-assembly

By S. M. WECKSTEIN
Industrial Equipment Engineer
Timken Roller Bearing Company
Canton, Ohio.

THE GENERAL adoption of anti-friction bearings in the machines and mechanical equipment used in various industries has been accompanied by considerable discussion, pro and con, concerning their effect on the general performance and general efficiency of the different devices on which they have been installed. Among other things, the matter of their influence on the general maintenance of equipment has been given a thorough airing, the consensus of opinion being that it is highly beneficial. For some reason much less has been heard about the precautions that must be taken if the fullest advantage is to be taken of such influence.

The statement that a thorough, periodic system of inspection is one of the greatest aids towards prolonging the effective life of the bearings, and consequently of the equipment, may come as a surprise, without altering its basic truth. A good many factors have helped to create such a situation by leading the operators of equipment, and even more responsible personnel, to take too much for granted concerning the ability of anti-friction bearings to operate under the most adverse conditions.

The only possible way to counteract the results of such belief is by a system of inspection that will disclose improper or abnormal conditions in the bearing assembly before they have time to cause any real damage. Of course there is always the alternative of the "ex post facto" inspection to see if the equipment can ever operate again, but its comparative value is doubtful, to say the least.

It is hardly necessary to go into details as to what constitutes a thorough inspection, or to emphasize the fact that its effectiveness varies in direct proportion to the care with which it is carried out. As to the frequency with which inspections should be made, that is governed entirely by the circumstances surrounding the case in hand. Some of the more important factors entering into the determination of frequency may be briefly summarized as follows:

The duty cycle of the equipment: whether it is continuous or intermittent.

The physical, atmospheric, and temperature conditions surrounding the equipment, with respect to cleanliness, absence or presence of moisture or corrosive fumes, and sudden or wide variations in temperature.

The class of duty performed. Whether it is in heavy or light service.

These are the most obvious, others will doubtless suggest themselves in individual cases. The best rule to follow is that dictated by common sense, supplemented by a thorough knowledge of the operating characteristics and the construction of the equipment.

With regard to the last factor, lack of a thorough knowledge of this sort on the part of the inspection personnel is very likely to lead to considerable trouble and expense. To take a case in point, a certain steel plant purchased a crane that was completely equipped with anti-friction bearings. During the original assembly of the crane at the factory where it was made, the bearings were supplied with just enough grease to permit them to turn freely, and to protect them during shipment and

erection. The crane was erected at the plant for which it was destined, and put into operation without being thoroughly inspected.

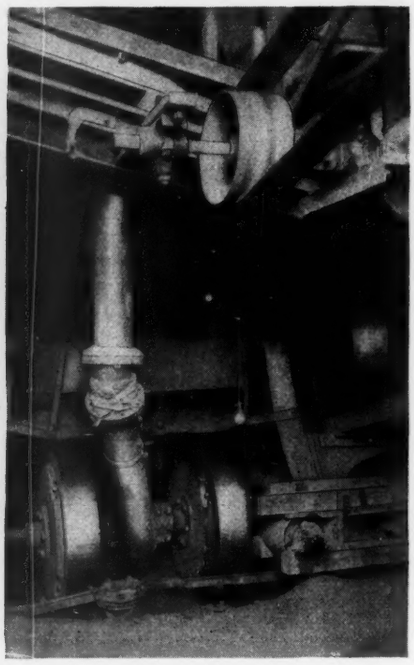
After the crane had been operating satisfactorily for about ten weeks, one of the drive shafts froze. This put the whole crane out of commission at a time when there were several heats of steel in the furnace ready to be tapped. When the crane was dismantled, it was found that the bearings in one of the boxes were bone dry. On closer inspection it was discovered that the lubrication hole in the box did not run clear through, consequently the bearings had received no lubricant aside from the small and entirely insufficient amount that was put on them at the time of assembly. Undoubtedly, the man who had attempted to fill the box on his regular rounds had assumed that it was full and had not taken the trouble to inspect it further. A close inspection of the crane by some one familiar with equipment of that sort when it was installed, or even after it had been running for a while would have prevented a very expensive shut-down.

Another spectacular and costly shut-down that could have been avoided by a close inspection made on the basis of a complete understanding of the construction of the machine in question happened as follows: A large gear reduction unit equipped with anti-friction bearings was installed to drive a heavy-duty machine. The erection men who set up the unit emptied a barrel of grease into the four bearing chambers, inasmuch as, each bearing cap carried a large plug for the introduction of lubricant.

The unit was started, and very shortly developed such excessive temperatures around the bearings that it was necessary to shut it down and pour water on the bearing housings to cool them. Upon inspection it was found that the unit was designed with gutters and channels to catch the oil splash from the gears and convey it to the bearings for lubrication. The grease had filled up these channels, thereby cutting off the oil supply, and furthermore, the bearing boxes were so full of grease that the friction caused by the churning action brought about the excessive temperature rise. After the grease had been thoroughly cleaned out, the unit was put in operation again. Although this was quite some time ago it has run continuously without any signs of heating, or any other trouble.

Next, in logical sequence to the matter of initial inspection is the question of "how frequently routine inspections should be made." Since it is during the earlier service of equipment that the likelihood of damage from anyone of several causes is greatest, a careful watch should be maintained during such periods. Such a policy will have an added advantage in that it will furnish valuable information to serve as a basis for future procedure. This method worked out in one case where a factory installed a number of electric motors of various horsepowers and duty cycles, all of which were equipped with anti-friction bearings. The factory personnel was not absolutely certain of what the lubrication requirements of these bearings would be, so it was decided to resort to a system of frequent inspections to find out. The bearings were given an initial lubrication, and inspected every two weeks to determine the effectiveness and general condition of the lubricant. Some of the motors ran for six and some for nine months on the initial supply, from which it was deduced that an inspection every three months was sufficiently frequent to keep them out of trouble.

The next point to be considered is what constitutes a thorough inspection. Whatever else it may mean, it does imply more than a casual inspection to see if the bearings have been receiving enough lubricant. There are a good many things that may be wrong with a bearing that will



WHY SOME BEARINGS ARE EASILY MAINTAINED. These motors and blowers are all equipped with anti-friction bearings mounted in housings so designed as to permit of easy inspection and lubrication. Such bearings are not likely to be neglected.

DRAW YOUR OWN CONCLUSIONS. The plant's physical condition usually governs the frequency of inspection, but not so in this brick plant. The dust-covered bearing at the right is a sample of the sort of thing that runs maintenance costs up.

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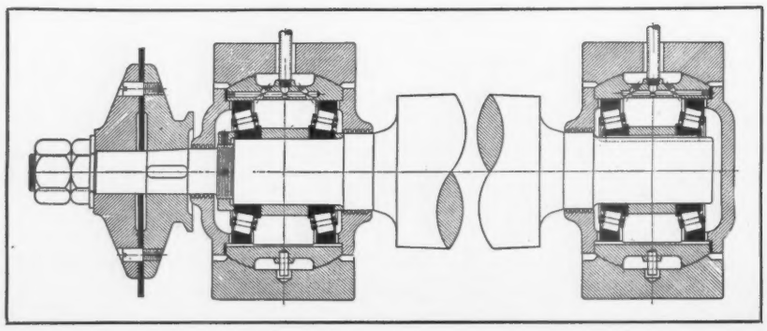
ANTI-FRICTION BEARING design for a hot-saw spindle. A study of the layout and operating conditions will prove the necessity of an effective and well maintained lubrication system.



not give any external signs until it is too late to remedy them. For instance, as has been pointed out, too much lubricant may prove as bad, if not worse, than not enough. Foreign material, dirt, or moisture may have worked its way into the closure in quantities sufficient to cause severe damage. Signs of wear in the bearing proper are also at times practically impossible to detect without a close examination. Even if these things were not true, it is a good policy to clean the bearings periodically by flushing out the boxes with kerosene and putting in a fresh supply of lubricant.

INSPECTION AT LOW COST IS OBTAINABLE. Where there is a group of bearings in one spot, inspection can be made very rapidly and effectively.

* * * *

Probably the most dangerous possibilities are the failure of the lubrication, or the unexpected occurrence of conditions, internal or external, which may practically destroy the scheme developed for supplying lubricant. A number of interesting cases of this sort may be cited.

Hot saws in steel mills are called upon to stand very severe continuous service over long periods of time. The old-style bronze bearings were a constant source of trouble because of their inability to withstand the shock loads encountered. Several methods of applying anti-friction bearings have been developed, so a typical one that has worked out successfully in use is shown on page 148. Because of the speed of operation and the temperatures developed, provision must be made for shaft expansion. This is accomplished by positively fixing the bearings at the saw end of the arbor, and allowing those at the other end to float. The inner races of these bearings are keyed to the shaft and have a looseness of about 0.007 in. on the shaft, to permit the establishment of a film of oil, which is depended upon to take care of the floating. From this description it can be seen that the secret of the successful operation of such an arrangement is the circulating oil system which has been developed to maintain the film.

When this particular mounting was first put into operation, over two years ago, the circulating system was closely watched to determine the correct quantity of oil required. If the supply was cut down to any extent the floating bearings promptly froze to the shaft, thus shutting down the saw. With the oil system working properly, the saw has been in continuous operation from 10 to 20 hr. a day for months at a time. No further emphasis on the value of careful and frequent inspection is needed with regard to this case.

One recent case of an expensive and avoidable failure has come up which can be directly traced to the lack of a proper inspection system. Briefly the story is as follows: A large steel mill using a number of rolling mills equipped with anti-friction bearings encountered considerable roll breakage which was caused by improper cooling of the working rolls. The cooling method was consequently changed from a circulating system through hollow rolls to a method wherein a stream of water was thrown against the outside of the roll body. In designing the bearing chucks for the mills, lubrication inclosures were developed which were very effective when the rolls were cooled as originally intended, by a circulating water system inside. When the cooling system was changed, no thought was given to a possible necessity for redesigning the bearing inclosures or for changing the lubrication scheme to prevent water from entering the bearings.

The mills operated continuously and successfully until quite recently when it happened that a part of the mill, which was in no way connected with the bearings, broke on one of the stands. The stand was completely dismantled and, during the process, the bearings were inspected. They were all in good condition except one, which showed signs of etching, corrosion, and excessive wear. It was found that water had entered the chuck of that bearing quite freely and had emulsified the lubricant,

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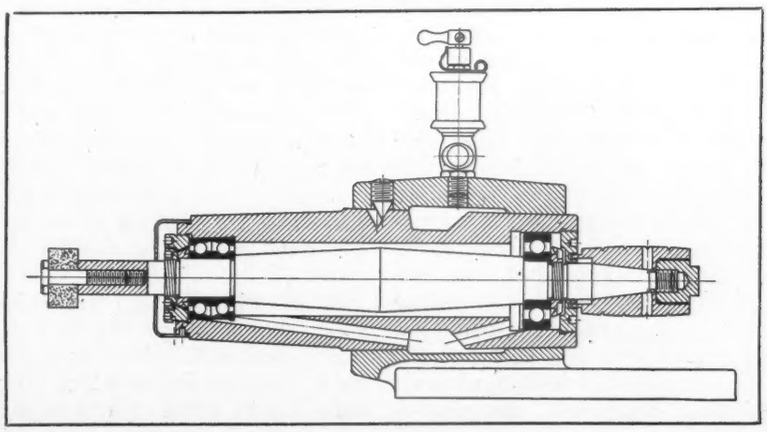
BEARING FOR HIGH-SPEED applications. A typical bearing application for grinding machine spindles. Note the provision for compensating for wear.



forming a soapy mass which failed completely to protect the bearings.

If the rolls had not been taken out, owing to a purely fortuitous circumstance, the condition of the bearing would probably not have been discovered until a serious breakdown had occurred. Even as it was, it was necessary to replace the spoiled bearing with a new one, at considerable expense. The entire lubrication scheme is also being revised to avoid future trouble from the same source.

Periodic inspection which includes a thorough examination and cleaning, or flushing, of both bearings and housings is especially necessary for machines operating in cement mills, brick and tile plants, on excavation projects, or in any sort of work where the surrounding air is likely to be saturated with dust or grit. Fine foreign particles will inevitably work their way into the bearing inclosures, and into the bearings themselves, under such circumstances.

Failure of the lubrication system, or the appearance of slight wear in the bearing arising from the speed of operation and the initial tension in the bearing set up will develop chatter marks on the finished product. Consequently the inspection of the finished product serves as a check on the inspection of the machine. The operator can then be advised of the necessity for taking up on the bearing adjustment to compensate for wear and looseness of the spindle. He can also be warned to watch the lubrication and general condition of the bearings. As a contrast, consider the value of a rigid, periodically frequent inspection that will correct improper conditions of wear and lubrication before quantities of spoiled products have called attention forcibly to their existence.

One could go on indefinitely citing cases hypothetical or actual that prove the value of proper inspection. The cases given may be regarded as too spectacular, and too specialized, to serve as a true criterion of the matter. They are not—they have been deliberately chosen to show on a large scale what is happening on a small individual scale throughout industry, and what in the aggregate amounts to an enormous waste of money, time, and effort. It may be argued that the time of the personnel having the knowledge necessary for making really effective inspections is expensive, but the cost of bearing failures is apt to be much more so. It may also be claimed that such inspections would delay production by putting machines temporarily out of commission. Bearing failures put them out of commission more than temporarily, sometimes they do it permanently. It all comes down to the question of which looks better on the books, a small steady expense for inspection and maintenance, or the sudden appearance of large sums chargeable to deferred maintenance, or, in the worst cases, to new equipment? To anyone interested in economical plant operation, the answer is obvious.

Selecting Lubricants for New Equipment

(Continued from page 126)

forms, or rolls perform their function, is our chief concern. Normally these so-called reactionary pressures will be exerted only when such a machine is producing. When idling the bearings and so on will usually be subjected only to the normal load resulting from the weight of the moving parts.

It is for this reason that the range of probable operating pressures must be known prior to the selection of lubricants for such equipment as textile printing machines, rolling mills, and metal presses.

Operating temperature is perhaps the greatest variable met in the lubrication of industrial plant equipment. Furthermore, it has a marked effect upon the behavior of practically any lubricant. As a general rule, the higher the temperature, the more fluid such products become. Under extreme conditions the lubricating film will frequently be too light to withstand the operating pressures.

On certain types of industrial machinery high operating temperatures may consistently prevail, for example, in glass plants and rolling mills. In contrast, abnormally low temperatures will frequently prevail in the operation of mining machinery, excavating equipment, refrigeration plants and other work of this nature.

It is not logical, therefore, to select a lubricant according to its measured viscosity at a standard temperature such as 100 deg. or 210 deg. F. The probable operating temperature should be ascertained and the approximate viscosity at this temperature determined by reference to a suitable viscosity-temperature chart. In this way, the purchaser can choose a product that will have the requisite body or viscosity at the operating temperature to maintain a lubricating film of sufficient thickness to prevent metallic contact, provided, of course, that abnormal conditions do not develop which might impair lubrication.

The extent to which automatic lubricating equipment is employed will also have a bearing upon the initial selection of industrial and power plant lubricants. Primarily, the viscosity or body of lubricating oils, and the consistency of greases, must be considered from this standpoint, for adaptability to handling by the methods employed will be the important factor.

Where high bearing pressure is involved, heavier lubricants can be used than where bath, splash, or drip oiling is provided for, or where greases must flow by virtue of heat or pumping action, as in certain pin-type grease cups.

Pressure lubrication is, of course, a decided advantage wherever practicable, for it not only permits the use of lighter and more readily handled lubricants, but also makes possible the maintenance of a lubricating film under more or less pressure. This aids in counteracting bearing pressures, as well as any tendency to squeeze the film from between the wearing elements. Normally pressure lubrication is, however, practicable only on the sleeve-type bearing where adequate enclosure is feasible.

With greases it involves application to bearings by means of pressure guns or spring-type lubricators. Grease lubrication under pressure may be said to be decidedly advantageous in that it normally provides a means of cleaning bearing clearance spaces and oil grooves of accumulations of foreign matter or caked lubricant.

Finally, the manner of guarding or protecting gears, chains, and other wearing elements must be considered in the light of the fact that this will influence the degree of cleanliness that can be maintained and the extent to which lubricants can be prevented from becoming contaminated.

Ewing Galloway, N. Y.

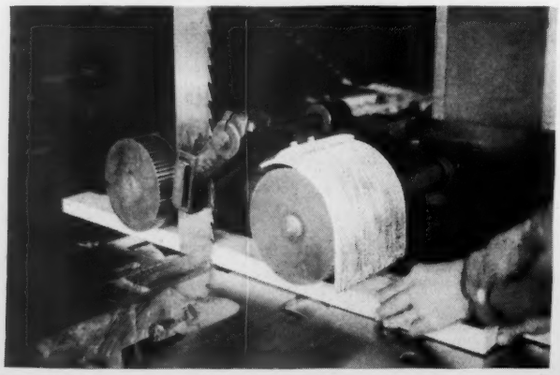
Which EXIT *Will You Choose?*

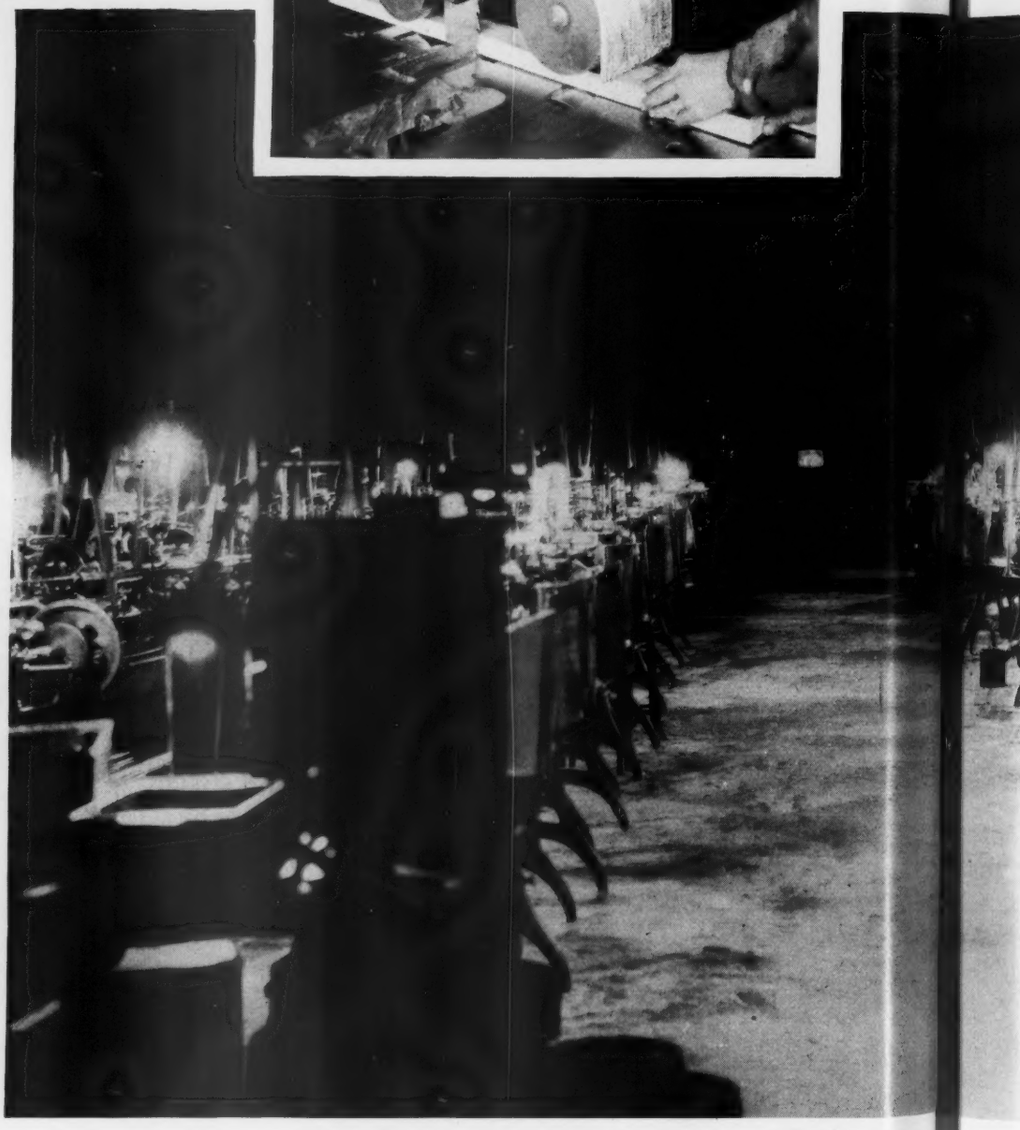
CARELESSNESS of the individual is still the greatest factor to contend with in the reduction of industrial accidents. A slip in the "I'll take a chance" game adds another name to the accident list. Of course, there will always be the plant "cut-up" who specializes in this game. This type is shown at the right in a one-man act. This man probably left the plant on a stretcher. Another way out is shown in the above illustration. The "safe way" out depends upon the safe way in—the plant. Individual vigilance will enable every employee to choose the way out.

Safeguarding the M

Multiple safety devices constitute an effective barrier against injury. This welder is wearing shatter-proof glasses besides using the shield to protect his sight from the intensity of the arc when welding. Be sure you're safe first, then go ahead.

Buzz saws by any other name are dangerous playthings. Where the work is automatically fed to the saw, an inexpensive curved guard like the one shown below may mean the difference of a few fingers. Watch out for unguarded devices in your plant.



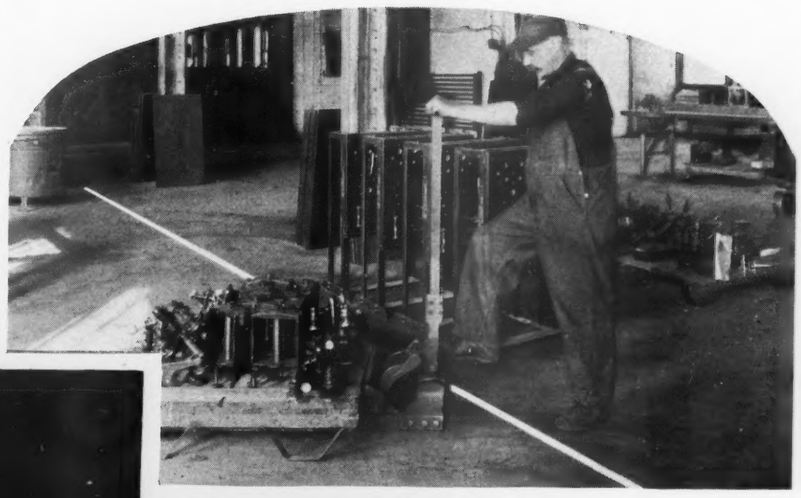


Wooden steps and stairways in dark corners are dangerous thoroughfares. Travel ways in repair guarded, free from obstructions and well lighted, represent good housekeeping.

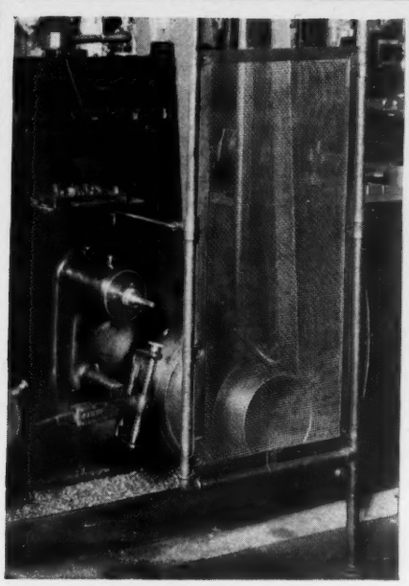
Here is where an illuminating engineer would make a killing. As an example of incorrect lighting, this is *it*. Glare predominates at the working plane concealing everything above it. The overhead line-shafting is entirely invisible. Instead of asking, "what's wrong with this picture," substitute and say, "what's wrong with this plant?" A better lighting system will be appreciated by your employees who work at night. Why not get their opinion on the present system?

the Men in the Plant

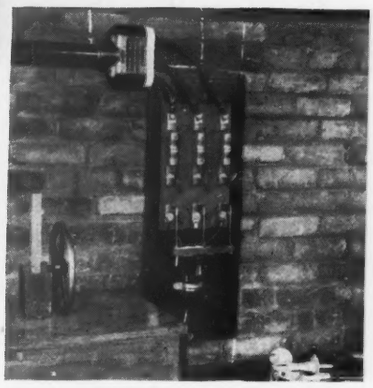
Labor saving tools safeguard the employees. Well defined traffic lanes speed up production in this plant. These lanes are painted on the floor to enable the men to move material in all directions quickly and with safety. The low-lift platform truck saves time and energy.



No, this is not the treasury, but a corner in a storeroom. There is a place for everything and it is put there. The platform ladder is double-ended and has wheels on one end only. Yokes under the other end prevent its moving when storing in the top bins. Not a bad idea?



Not all screens are classed as ornaments. Some combine utility with ornamentation. The screen shown at the left embodies both. It protects the passerby. When adjustments are to be made to the belts on this shaper the screen is unlatched and turned to one side. A good idea is worth while if it is put to use.



Open-type switches are still made and installed. A few cents more would have provided a totally-inclosed switch. It is cheaper to buy proper equipment than to pay for damages. Any exposed switch is a source of danger. Why not plan to eliminate them this year?

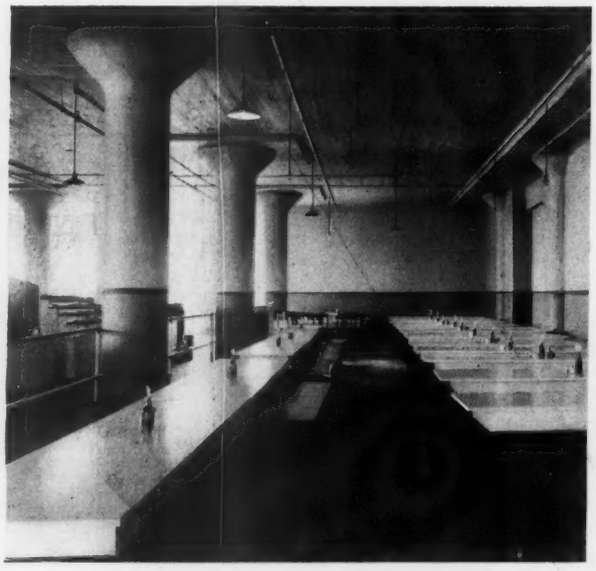
Built-in, explains the view above. Casement windows for ventilation. Excellent daytime lighting and a painted interior to reflect the light. The savings in insurance premiums due to the sprinkler system probably defrays the window washing expense.

Why take a chance with infection when facilities like the above are provided? This is the first-aid room in a Long Island plant where employees receive emergency treatment.

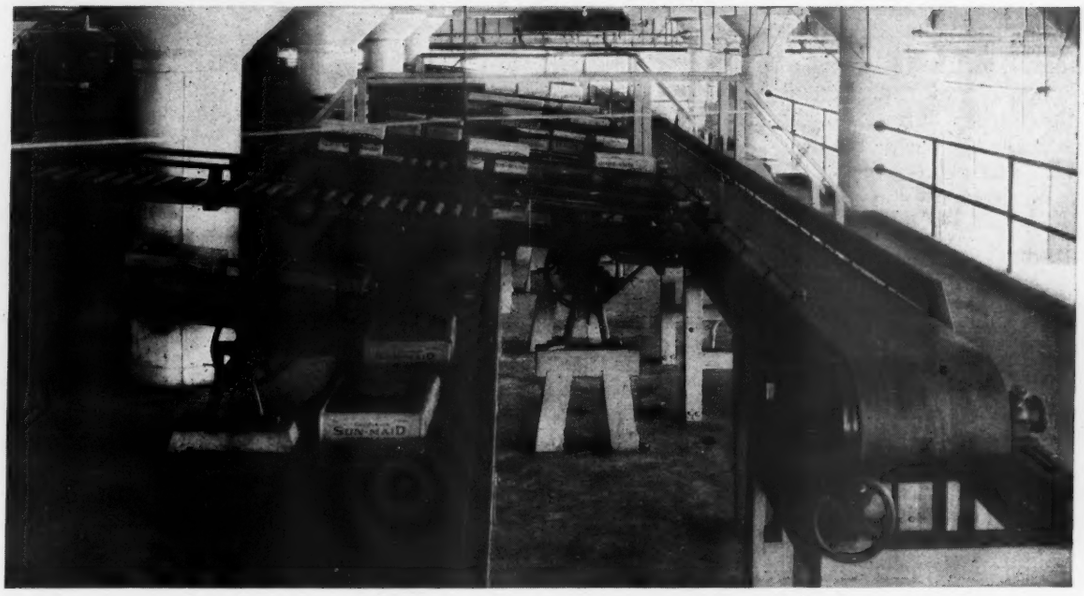
Safeguarding the Men in the Plant

THE happy industrial family is always found where modern innovations have been provided for the unrestricted use of the employee. Industry as a whole is strong for equipment that will make for better products. See that you have the best.

The Central Gear Company of Detroit, Mich., believe in good housekeeping as an aid to production. Over 1,000 Lyons steel lockers are in line with their scheme of sanitation.



A corner in the cafeteria of the Westinghouse Electric & Manufacturing Company's South Philadelphia plant. Industry helps the men to help themselves. Food supervision is a necessary safeguard, and it pays.



Easy accessibility of all parts is a feature of this combination of gravity roller and belt conveyors for handling dried raisins

MATERIALS HANDLING EQUIPMENT

REPLACE IT—*when proper maintenance will no longer keep it in operation—advises* EDWARD J. TOURNIER

IN EVERY up-to-date plant all machines are inspected periodically and necessary repairs made to the end that they may continue in service. Equipment that has become obsolete through age or because of the introduction of more efficient designs, is replaced. The modern plant cannot risk a loss of production, through lack of inspection, maintenance, or the necessary replacements of its tools.

Materials handling equipment is no less a tool of production than is the turret lathe or the bandsaw, and the elements that make up a conveyor system require the same consideration of their mechanical well-being as do other tools.

The fundamental types of conveying equipment used in manufacturing processes are few in number, which simplifies greatly the problem of inspection. These types have as their principal elements, gravity rollers, chains, belts, overhead carriers, lift trucks, elevating platform trucks, and tractors. With most of them lubrication requires the greatest attention from inspectors and service men.

In those forms of chain conveyors in which plain links slide on metal guides, economy in power consumption depends on well-greased tracks. On conveyors in which the chains are equipped with rollers, the latter, as well as the chain joints, require periodical lubrication. Overhead trolley carriers, being closely related to roller chain equipment, present much the same problems of lubrication.

Belt conveyor installations require frequent attention to insure proper lubrication of idlers, if the latter are of the plain bearing type. As the belt-carrying rolls or idlers are the source of friction in all belt conveyors it is essential that frictional resistance be reduced to the minimum by an adequate supply of lubricants. Friction losses due to the terminal pulleys and transmission represent only a small percentage of the power consumption of belt conveyors. Furthermore, it is a practically constant amount, whereas the frictional increment of the idlers is directly proportional to the load carried and to the length of the conveyor.

In all of the chain-type conveyors the terminal pulleys likewise account for only a small fraction of the total power consumption, so that, as in the case of belt conveyors, lubrication of the power elements does not present a serious inspection problem. This is not to say that the terminals can be neglected; however, the problem lies rather in taking care of the wear of moving parts, such as gears, chain drives, and speed reducers.

Gravity roller conveyors do not present the lubrication problem that is encountered with chain and belt

conveyors, because all such equipment is constructed with anti-friction bearings, mostly of the ball type. A sufficient amount of lubricant is placed in the bearings during assembly to last practically the life of the bearing. In fact, many conveyors of this type have never been lubricated because no provision is made for the application of oil or grease.

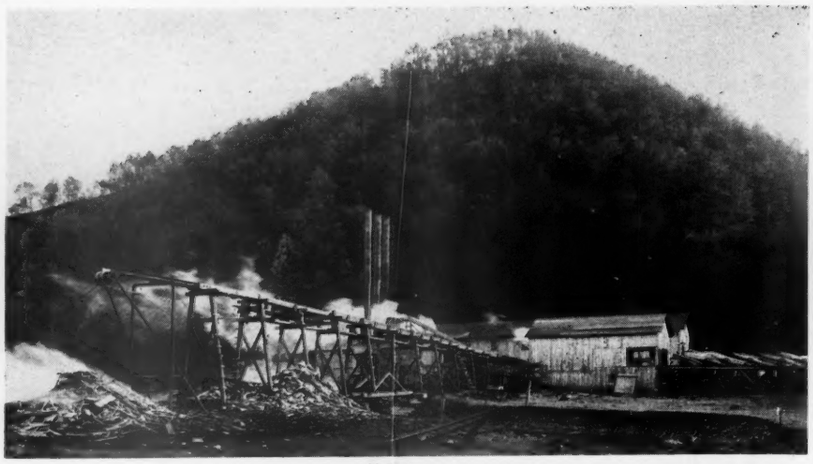
Systematic Inspection Reduces Repairs

The practice followed in many plants of writing off the value of new equipment on the basis of total depreciation in ten years or less, is a valuable guide in the consideration of repairs. Where materials handling equipment has always received systematic, periodical lubrication, depreciation will not occur for perhaps twenty years. The book value would then be eliminated, but the functional value could easily be 75 per cent.

As an instance the case of two flat belt conveyors handling bags of grain in a Jersey City warehouse may be cited. These conveyors were installed in 1918 since which time they have handled more than five million bags weighing a total of 380,000 tons. The repairs consisted of one belt renewal at a cost of less than $300. These conveyors would still be in service except for the fact that the warehouse had to be demolished last year.

If it were permissible to mention plants in which lack of inspection has resulted in lowered efficiency and loss of production, it could be shown that an investment loss equal to five years' depreciation has occurred in some cases, and that the loss in anticipated productive capacity was more than 25 per cent. It should be noted, however, that such instances are extreme cases, because with the continuous processes required in most industries mechanical handling equipment that does not function at least 85 per cent of the time is too expensive. The other 15 per cent is taken up by the weekly day of rest.

An extreme case occurred in a sand-washing plant not many years back. A portable belt conveyor had been installed under a bin containing 20 tons of mixed sand and water—an excellent grinding compound. The machine had been sold for handling damp sand, which was to be fed uniformly to the loading end of the machine. It is well known, however, that portable conveyors are versatile workers, and also abused. The owner of the plant decided to use the conveyor under the washer to load a fixed conveyor, the portable machine receiving as much of the 20 tons as would flow out of the bin gate. The receiving end was submerged in water, which flowed around the lower part of the belt, covering pulleys and bearings with the worst kind of abrasive material.



A SINGLE-STRAND, SLIDING-CHAIN TYPE CONVEYOR handling saw mill refuse.

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The result was that within a week the belt was full of gravel holes, the tail pulley and bearings were worn out and the drive chain was cut down to a thread. In addition, the motor sprocket was ground down to the hub. Eventually the machine stalled from overload, and the motor armature coils were burned out. The total cost for repairs was more than $100 for a machine costing less than $700, and the loss of production for three days amounted to more than 1,500 cu.yd. of material.

In referring to depreciation periods of twenty years, as previously mentioned, some note should be taken of cases where machinery becomes obsolete in less time, due to the introduction of more efficient equipment. In this connection, it is common knowledge that assembly conveyors in automobile factories seldom remain in service more than two years, due to changes in methods of working, improvements in transmissions, and other details.

One of the most important changes now taking place in conveying machinery design is the use of anti-friction bearings and pressure lubrication, which are of advantage from the maintenance standpoint. In addition, power consumption is reduced 30 to 40 per cent, which in the case of long horizontal conveyors means large enough savings to pay for the extra cost of the new bearings. On long, inclined conveyors carrying large tonnages, much of the advantage of low frictional resistance is lost on account of the lift horsepower. The advantage that is of greatest moment, however, is that inspection and lubrication attendance is reduced to one-tenth of the amount formerly required and the labor thus saved is

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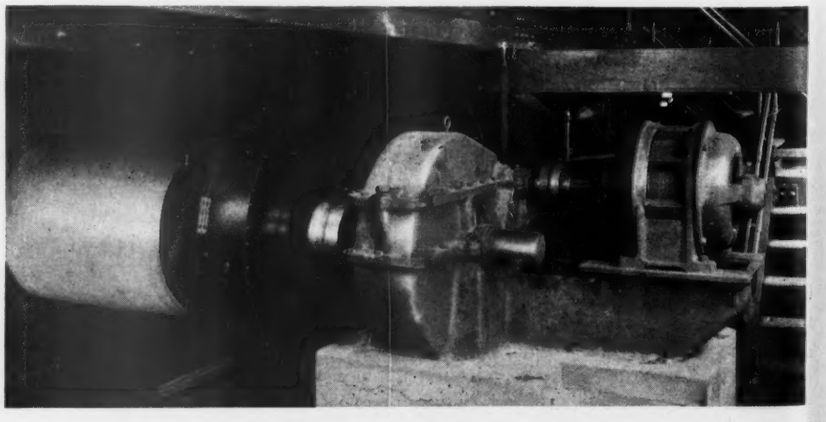
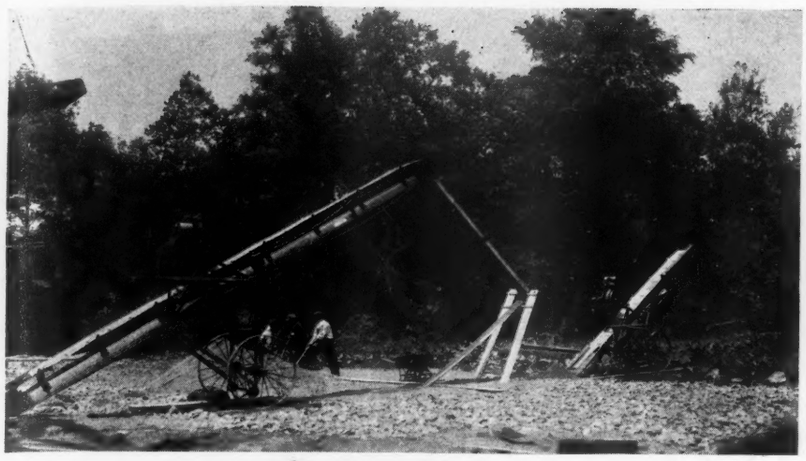
DRIVING A BELT CONVEYOR through a speed reducer facilitates lubrication and maintenance.





PORTABLE CONVEYORS ARE STRONG, but there is a limit to the abuse they can stand.

* * * *

directly available for productive use.

General experience has shown that no radical changes in mechanical handling equipment occur within the period of usefulness of any given type. For example, it is extremely unlikely that new designs of low-friction bearings in conveyor elements will greatly reduce maintenance or power consumption within the period of total depreciation of such equipment now being installed. There will be no gain, therefore, in changing from one kind of anti-friction bearing to another, unless one of them was unsatisfactory because of improper application. The gain will be for those who change from plain bearings to anti-friction bearings.

It is a safe assumption that an installation of mechanical handling equipment with anti-friction bearings in rollers and journals will not become obsolete through further reduction in friction factors during its period of usefulness. It is, of course, a different matter where that type was required and something different was used. Equipment such as the latter is obsolete before it is placed in service. It follows, therefore, that proper selection of equipment is now more important than ever. Wrong selection is responsible for more unsatisfactory performance of conveying equipment than any other cause.

Selection of Equipment by Engineering Analysis

There is no set rule by which we may fix a time for replacements of materials handling equipment, but there is one common-sense practice that serves as a rough guide. This practice is to keep the machinery running by means of proper maintenance as long as it can be made to go without breakdowns. In general, all such equipment is of simple construction, rugged, and easily attended to. Furthermore, as already pointed out, radical improvements are infrequent. Therefore, careful watching of new developments will enable the plant management to replace old, obsolete equipment with the improved types.

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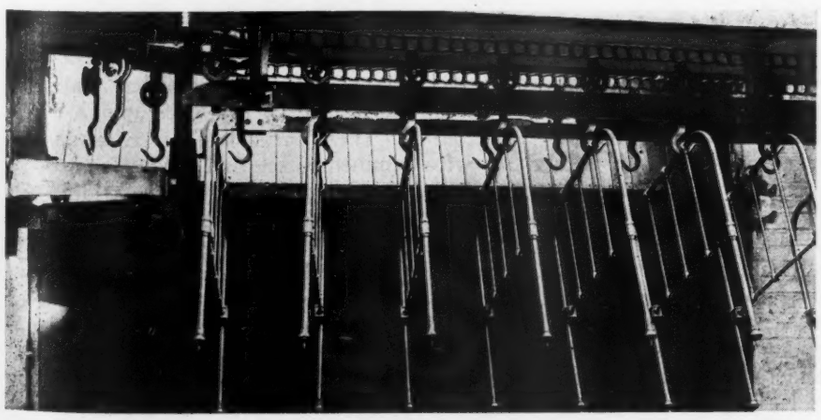
A SINGLE-STRAND CHAIN CONVEYOR designed for low frictional resistance.



That the selection of the agencies of economical production is a function of management is not open to question. Upon the proper choice of all equipment, whether it be engines, boilers or conveyors, depends the efficient production and orderly progress of materials through the plant.

The choice of boilers, for instance, is a very definite problem for which there are rules, both mathematical and empirical. These rules are generally known to plant men, as are also the specific purpose of the boilers.

In giving consideration to materials handling equipment, however, the case is quite different. Here, also, there are rules and mathematics, but each manufacturer has rules of his own and the mathematics of any two do not always check.

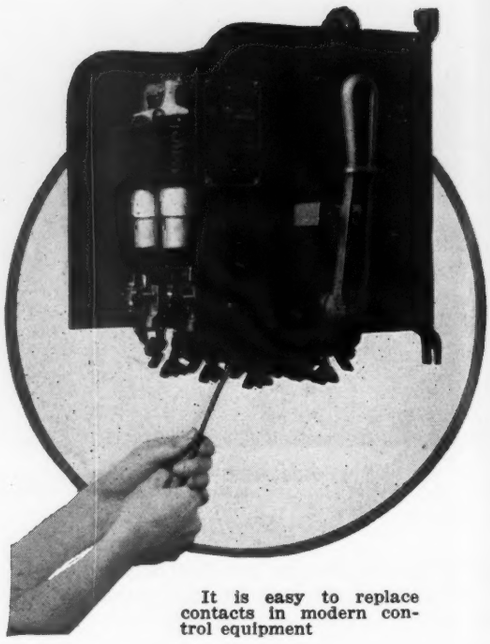
In most cases a problem of mechanical handling is placed before a number of manufacturers, each one of whom builds a different kind of equipment. Each manufacturer will make a more or less careful examination of the conditions to be met, and will recommend whichever of his products meets the requirements, as he sees them. Eventually there come to the user as many analyses as there are bidders for the work. Each of the solutions offered would do the work; some of them would perform well, and others not so well. The important point, however, is that perhaps none of the proposed systems exactly meets the situation or is the best that can be done. The user must select one of the propositions submitted without being able, in many cases, to decide which one is the correct solution of the problem. Aside from the question of price there is only the general experience of the buyer as a guide.

There is no fault to be found with the vendors, each one of whom is sincere in the belief that his solution is the correct one. Equally blameless is the buyer who considers intelligently the various offerings and decides on their merits as they appear to him.

A serious fault exists, however, in the method of selection by individuals who, in the nature of things, cannot be unprejudiced. One of them may be disinterested as regards the different vendors, but cannot make technical decisions. Another is technically qualified, but is not disinterested. The true solution will be found through the examination of all of the engineering, economic, and commercial factors involved, by engineers who can combine technical ability with a disinterested viewpoint.

Systematic Procedure for

Maintenance of CONTROL Equipment



It is easy to replace contacts in modern control equipment

By H. D. JAMES

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PROPER maintenance of control equipment, or any equipment, is a joint responsibility of the manufacturer and the user. The manufacturer must design his product so that the parts that require attention are easily accessible. He should use standard hardware, such as screws, nuts, and the like. Wherever possible the parts should be constructed so that they can be adjusted or renewed by means of a screwdriver, wrench, or pair of pliers, as special tools are not usually available for field inspection.

The user is responsible for locating the control so that it is accessible for inspection and ordinary operating renewals. It is important to leave enough space to give the maintenance man plenty of room to work in. Means should be provided for easily disconnecting the controller from all power circuits when it is being worked upon.

A regular and systematic program for inspection and maintenance should be established and closely supervised. Many delays in manufacture are due to the fact that the equipment is not properly inspected and maintained, with the result that a breakdown occurs and valuable time is lost. This applies to all equipment, including control.

The owner should maintain an adequate stock of renewal parts so that any detail which requires renewal can be replaced promptly. There is nothing so discouraging as to have a valuable machine shut down because some renewal part is not available or does not fit. It is desirable to have these parts made from the same set of tools used for the original parts. A few dollars spent on a stock of renewal parts pays splendid dividends in the continuity of operation.

The maintenance of control equipment can be divided into two classes: namely, field maintenance and overhauling.

Field Maintenance

Field maintenance covers the frequent inspection of control equipment, together with the necessary adjustments and renewal of contacts, arc shields, and other minor work necessary to keep the controller in operation.

Means should be provided for cleaning the control. A low-pressure air supply is very useful for this purpose. Where an air supply is not available a hand bellows is recommended. If a cloth is used for wiping the dirt from the controller parts, care should be taken not to bend any of the lighter elements, or disturb the adjustments. Waste should not be used for cleaning electrical apparatus, as it often contains metal particles and small pieces of cotton thread will adhere between contact surfaces.

It is particularly desirable to remove the dirt from insulating surfaces. Oil used for circuit rupturing or dashpots should be inspected and renewed when necessary. The contacts and arc shields should be examined and given the necessary attention.

Before leaving the controller, the inspector should watch its operation carefully; an experienced man can tell by the performance of the controller whether it is in first-class working condition. Often minor adjustments will materially reduce the burning of the contacts and improve operation.

Contacts—Controller contacts rupture the circuit and, therefore, gradually burn away. Of late years considerable improvement has been made in designing the control contact parts particularly on magnetic contactors. On severe applications contacts will now last a month, where as formerly they required renewal every week. On most applications the contacts will last for several months, or even for several years, depending upon the frequency of operation and the amount of energy interrupted.

These parts should be carefully examined to see that the surfaces make contact over their entire width. In sliding contacts the burrs should be removed with a file and the surface smoothed with fine sandpaper. However, rolling contacts, such as are used with magnetic contactors, should not have their surfaces filed or cleaned if they are used frequently, as they wear themselves to a satisfactory

seat. When these contacts are renewed the pair should be changed as a new contact will not operate satisfactorily with one that has been burned.

If contacts are operated infrequently, an oxide film may develop on the surface, so that it is desirable to clean them with fine sandpaper at regular intervals in order to maintain their conductivity.

Each pair of contacts is provided with a spring for maintaining uniform pressure between the surfaces. This spring pressure should be tested each time the controller is inspected, to see that it is kept within the limits specified by the manufacturer. A small spring balance is very satisfactory for this purpose. The hook can be provided with a stirrup for slipping over the contact between the contact surfaces. The pressure should be measured with the contacts in the closed position.

Contacts are made heavy enough to withstand considerable wear without loss of efficiency. They should be renewed before they are worn down so far that they do not function properly. Contacts that are worn out have a tendency to weld or "freeze" together.

Sliding contacts that are operated frequently, as in drum controllers, may have their life materially increased by the use of a little Vaseline on the rubbing surface, provided the controller is kept free from abrasive dust. Do not use any form of lubrication on the sliding surfaces or bearings of a controller exposed to abrasive dust, as the oil holds the grit on the surface and increases the cutting action. An oiled bearing, if clean, will last much longer than a dry bearing, but wears out faster if exposed to grit. If the contact surface of a drum or faceplate controller is lubricated it should first be wiped clean and dry and the lubricant spread smoothly over the surface with a cloth or small brush. The controller should then be operated a number of times and any surplus grease removed from the edges of the contacts.

HOW THE HEATER for an overload relay is mounted.

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The contact finger of a drum controller should be adjusted so that it drops from $\frac{1}{16}$ in. to $\frac{1}{8}$ in. below the surface of the drum segment when in the off position. Too much drop may cause the finger to be "stubbed" or bent. Insufficient drop will prevent it from making proper contact.

Arc Shields—Arc shields and arc boxes gradually burn away under frequent service. When the controller is inspected the surface next to the contacts should be cleaned by scraping with a screwdriver or other flat tool. Frequently the material of which arc shields are made has a binder that fuses and forms a crust on the surface. This crust is usually a conductor of electricity and may interfere with the proper functioning of the contacts.

Shunts—Most moving contacts are connected to the circuit by means of a flexible shunt. These shunts may break in time and require renewal. A careful inspection of the shunt will show signs of failure in plenty of time to renew it. Often the breaking starts on the under side of the shunt; so it may be necessary to detach it for inspection. The life of a shunt may be materially decreased if it is bent in an abnormal manner.

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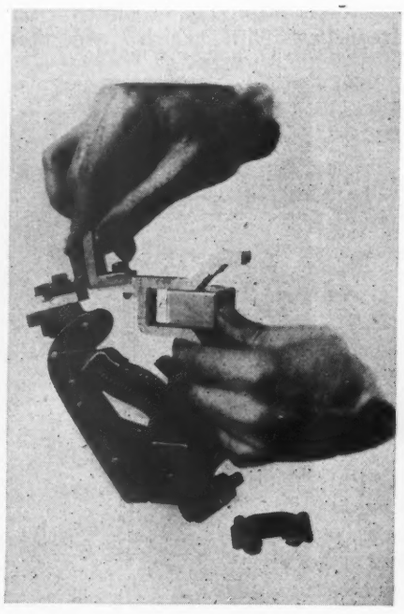
HOW EASILY the parts of a cam controller can be renewed. The contact parts are held in place by a clamp and two hex-head bolts with a slot for a screwdriver.

Magnet Contactors—The armature should be inspected to see that it operates freely and seats properly when closed. If the bearings are worn the contact members will not have the proper rolling action and may weld or "freeze." Burning will also be increased.

In the closed position a.c. magnets take current in proportion to the size of the permanent air gaps in the circuit. If any of the parts of the magnetic circuit have been displaced so as to increase the air gaps, more current will be taken by the coil and may cause overheating. If a magnet coil overheats, the line voltage should be checked carefully and, in the case of an a.c. magnet, the iron circuit should be put in first-class condition.

Relays—There are so many types of relays that only a general statement can be made regarding them. Most relays are small and have light contacts; they should be carefully inspected to see that the parts have not been bent and that the contacts properly engage each other. Overload relays should be inspected to see that they are set for the proper tripping value. If oil dashpots are used, the oil should be examined to see that it is clean and of the proper density. Any bypasses or check valves should be carefully cleaned and adjusted. Operate the relays by hand to make sure that their action is free and normal.

Interlocks—Electrical interlocks are usually small contact members and may be the source of considerable trouble if not kept in good working condition. Their functioning is usually very simple, so that a good inspector can easily tell when they



are operating in a satisfactory manner.

Mechanical interlocks are usually quite rugged and are for the purpose of preventing a wrong sequence of operation. They should be tried by hand to see that they operate freely and are in proper adjustment.

Safety Features—Most controllers are provided with safety features such as overload relays, low-voltage protection, etc. The functioning of these devices should be carefully tested, particularly those features that guard against injury to persons. If emergency stop devices are located on or about the machines they should ALL be tested.

Wiring — Wiring connections should be inspected to see that they are tight, particularly at the terminals. Inspect the terminal connections on the resistors, as the high temperature to which they may be subjected sometimes loosens them.

Nuts and screws on controllers subjected to vibration should be examined for tightness at frequent intervals. This applies not only to the joints carrying current, but to all of the mechanical parts. Wherever practicable, lock washers of some type should be used. If an inspector finds a connection that does not have lock washers, his troubles may be materially decreased if he will put such washers under the bolt head or nut, as the case may require.

General—The foregoing list of things that require attention may seem quite formidable, but in actual practice it will be found that certain contactors and relays on a particular controller require more attention than others, so that the work of the inspector is materially simplified. The frequency with which inspections should be made depends largely upon the service requirements and the importance of the machinery driven. A little experience will enable the user to establish suitable periods for inspections.

Major Overhauling

From time to time it is necessary to dismantle a controller for a major overhauling. This is a bench job and requires that the controller be taken out of service while the work is being done. An experienced man can tell by an inspection of the parts, after he has dismantled them, what work is necessary to put them in good condition. Details of this work will vary over such a wide range that it is not practicable to discuss them in full; however there are a few things that should always be done.

1. The insulation should be thoroughly cleaned and revarnished. Gasoline can be used for cleaning insulation surfaces as well as mechanical parts, but it is very inflammable and must not be used where there is any open fire or danger of electric spark. Carbon tetrachloride is non-explosive and can be used where there is danger of explosions, but it is not so readily obtained as gasoline and, therefore, is not often used.

A good grade of insulating varnish should be used. When the facilities are available, coils can be given a vacuum treatment and reimpregnated. Whenever possible, insulating materials should be thoroughly dried in an oven before varnishing.

Controller parts may be clamped or fastened to insulating surfaces. In time the insulation under the clamp or metal part may be charred or worn away mechanically; it is, therefore, desirable to remove all such metal parts so that a thorough inspection can be made of the insulation underneath them.

Controller cases often have asbestos lining where they are exposed to the arc. This lining should be given a good coat of insulating paint and renewed where necessary. Any paint or varnish used must have good insulating properties; ordinary paint is not suitable.

2. Where bearings are worn, new pins should be used. If necessary the holes should be bushed. It is highly advisable not to change the size of the bearing, as they are usually made to gage and any change will prevent the use of standard renewal parts.

3. All clamped surfaces that carry current should be taken apart and cleaned. If these surfaces are covered with a thin coat of solder before they are clamped together again, they will be protected from oxidation and a more satisfactory joint obtained. All soldered connections should be examined to see that they are in good condition. If acid was used in soldering the metal may be partly eaten away. Acid should not be used when soldering connections: non-acid fluxes are readily available.

Control equipment, like any other machinery, will give long and satisfactory service when conscientiously inspected and maintained.

The cost of renewal parts is only about one-third of the total maintenance cost. It is poor economy to purchase "cheap" renewal parts, or for the user to try to make them. A liberal policy in this respect will without doubt pay handsome dividends.

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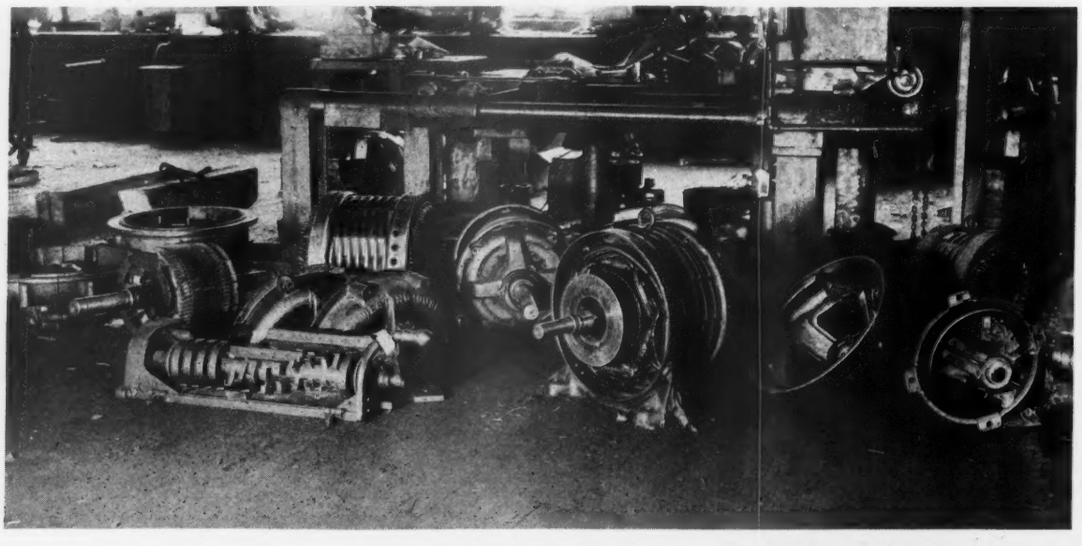
LACK OF ATTENTION while in service brings equipment to the repair shop, out of service.



H. C. DENT

Manager, Department of Industrial Engineering

describes the

Storekeeping Methods

of Joseph T. Ryerson & Company, Inc.

for Handling Maintenance Tools and Supplies

PROBABLY no other department in the average industrial organization is so much abused and neglected as is the department that has for its function the storage and distribution of tools, supplies and materials, both for use and consumption in plant maintenance work and for production or sale. In many instances tools and materials constitute a large part of the assets of a business institution. These assets are just as real and tangible in terms of dollars and cents as is the gold, silver and currency deposited in the bank for safekeeping; however, they are seldom regarded and conserved as is actual cash.

The tool and material (or supply) stores department is ordinarily considered as being only incidental to the main purpose of the business and is often allowed to shift for itself and becomes an asset or a liability to the business as accident would make it.

The problem of the control of tools may vary in its scope from the use and distribution of a small kit of hand tools in a small shop to the distribution, storage and control of elaborate modern tools, jigs and fixtures worth thousands of dollars, which are maintained and safeguarded by a corps of skilled toolroom keepers in specially designed rooms and buildings as are found in the plants of many of the large industrial institutions.

Conditions may vary but the matter of storing and safeguarding tools should be of no less importance to the small shop owner than it is to the manager of a large factory. That age old maxim, "A place for everything and everything in its place," is universally applicable.

The tool and material stores department, or the tool and supply room, should be as centrally located as is possible so as to make it easily accessible to the men having occasion to use it. Time lost by men going to and from the tool and supply room pays poor dividends. The room should be well built and provided with good ventilation and lighting. Racks and shelves should be provided for tools and each tool or each class of tools assigned a certain location. Compartments, containers and holders in a wide variety of sizes and shapes can be had to take care of the most complete assortment of special and standard tools, supplies and repair parts.

If suitable storage facilities are provided the man in charge of the tool and supply room has no excuse for not keeping it in order. Suitable and well-kept storage facilities are often reflected in more accurate records covering the stock on hand and in a reduction in inventory due to the fact that the tools and supplies are readily found when needed. Frequently, if the tool and supply room is kept like a junkyard, unnecessary tools and supplies are ordered because the quantities on hand could not be found when needed.

The manner in which the issuance of tools is controlled is deserving of consideration. Many very efficient systems for the control of tools are in use. This plant has used the tool check system for a number of years with fair success. The more important details of this method are given in the following:

Every employee who is authorized to draw tools is given a definite number of metal checks, each of which bears the numeral by which the employee is identified. The workman can procure as many tools as he has checks. When a tool is drawn the workman deposits one of the checks with the tool keeper, who maintains a record showing the kind of tool and the date withdrawn. The check is hung on a hook in the tool and supply room; the hook bears the same number as the check.

When a tool is returned the check is given back to the workman and the charge against him is cancelled from the tool keeper's record. Each Saturday all tools, excepting such as are in use or set upon machines, are required to be returned to the tool and supply room, thereby making it possible for the tool keeper to make a weekly check, a report of which is submitted to the superintendent informing him of broken and missing tools and giving him the check numbers of the men responsible for such tools.

When a workman is discharged or leaves the company for any reason he must return all tools and unused tool checks to the tool keeper before he can get his final wages; the paymaster withholds such payment until proper clearance papers have been issued by the tool keeper.

The question may be asked as to what the particular advantage is of giving such serious consideration to the storage and control of tools. The answer to this question may be gained from the following enumeratoins:

1. Tools are placed where they may readily be found because each tool has a particular place assigned to it.
2. Tools are kept in good condition. When a tool is broken it is immediately repaired or replaced with a new one.

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FORMS USED in issuing and recording supplies. The front of the loose-leaf Stores Record is used to enter receipts and issuances of supplies. The reverse is used by the Purchasing Department to enter data on material or supplies ordered. A separate sheet is used for each item which is identified by the stock number. Supplies are issued only on presentation of the Supply Requisition when properly authorized. These are sent daily to the purchasing department for entering the unit cost and deducting from the Stores Record; they then go to the cost department. To maintain a systematic check on the records a daily inventory is taken by actual count on a few items and reported on the daily inventory form. This checks over every item in the storeroom twice a year.

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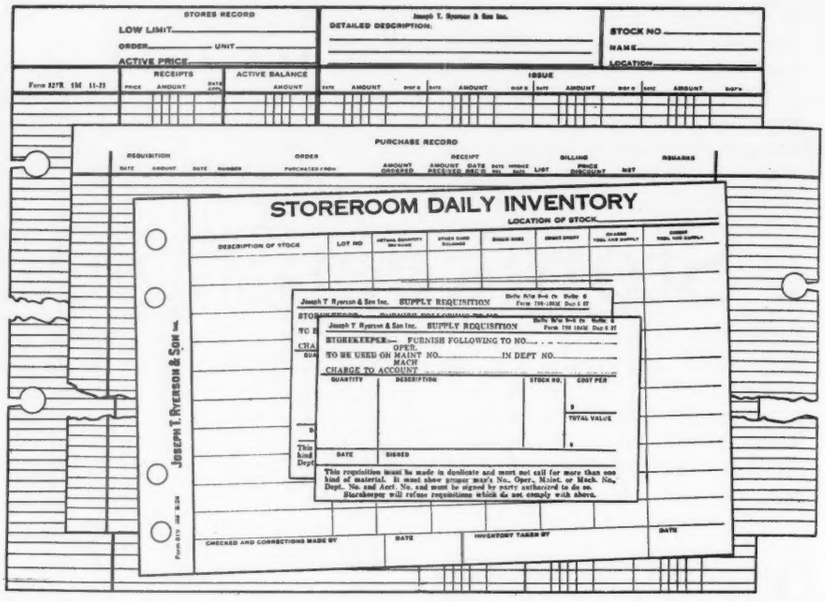

3. Tools that are needed are procured, but no necessary duplicates of tools already in stock are added.

4. Tools can be readily located and accounted for.

5. The cost of the upkeep of the stock of tools is small because tools that are lost, misplaced, broken or stolen must be satisfactorily accounted for and in some instances must be paid for by the man charged on the tool keeper's record.

6. Every workman is automatically charged with the good care and prompt return of all tools he draws from the tool and supply room. This makes the workmen more careful.

A practical system which makes for an efficient control of the storage and distribution of supplies and materials for maintenance and operating purposes is essential to the smooth running of an industrial institution. The system must, of course, be practicable and must be adaptable to the business to which it is to be applied.

To avoid delays in production, to prevent extended shutdowns of expensive equipment, and to avoid the dangers incidental to investing in large stocks of materials, a well-organized material stores system acts as an equalizer or as a safety check-valve. It provides for the maintenance of stocks of the proper quantities and of particular materials for certain uses.

As was the case with tools, the supplies should also be placed in suitable bins, drawers, racks and shelves so that the different items may be accessible and kept in good condition. In our tool and supply rooms each bin or container bears a number known as the "stock number" which serves to identify the item. In many cases, particularly with small items, a sample piece is wired to the front of the rack or drawer to facilitate locating the item desired, as is shown in an accompanying illustration.

A loose-leaf stock record *A* with one sheet for each item is maintained by the purchasing department. At the top of this sheet is shown the detailed description of the item and the identifying "stock number" with which the container in the tool and supply room is marked. The record also shows the high and low limit, the available sources of supply and the time required for delivery, including the time for transportation, price per unit and other data. The front of this sheet *A* is used for the stores record and the reverse *B* for purchase records.

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BINS OR SHELVES are adapted to materials stored and identified by number or other marking. The bins in this illustration are constructed of metal, and are clean, accessible and fireproof. Their sectionalized construction permits any rearrangement necessary for the storage of supplies.

OIL STORAGE facilities should give fire protection. Fire hazard is one of the important considerations in connection with the storage of paints, oils or other inflammable materials. The measuring equipment also aids in keeping record of quantities issued and showing quantities remaining on hand.

It might be well at this time to point out the advantages of the above mentioned high and low limits. By this is meant the maximum stock of any one item that is carried on hand, and the minimum limit that it is advisable to carry. These limits cannot be established without considerable experience and study. Naturally, they must be based on the particular requirements of the business, and, of course, the time required to obtain the item in question after it has been ordered.

It is evident that by keeping all the stocks of materials as close to a minimum as possible the result is a smaller investment of capital, less storage space is required and an increased turnover on inventory is obtained, all of which combined results in increased profits for the business.

Materials are issued from the tool and supply room only on presentation of a supply requisition *C* which must be signed by someone with the proper authority, such as foremen, dispatchers, and superintendents. The requisition shows employee's number, account, job or machine to be charged, and whether the material is to be used in operation, maintenance or on a particular machine. The storekeeper inserts such necessary data as weight, stock number, and so on. These requisitions are accumulated in the purchasing department daily, sorted according to stock numbers, recorded on the stock record, priced, and forwarded to the cost department where they are used for determining job costs.

A stock of about 5,000 items is carried. This has an inventory value of about $50,000 on which there is a turnover of between two and three times a year. To maintain an accurate stock control it has been found advisable to take a daily physical inventory of a definite number of items which are reported on *D* and are checked against the perpetual inventory maintained on the face of the Stock Record sheets. By this daily check on the inventory an actual count of all items is made twice a year. In this manner proper adjustments may be made between the amount actually on hand and the amount shown by the stock records.

Maintenance Practices at the Fordson Plant

(Continued from page 110)

Ford men take great pride in keeping their tools in excellent condition. The locomotives in the yards, every part of the power plant, and every surface which is supposed to be clean and bright is polished. Metal parts are carefully painted and kept in that condition. They are kept thoroughly clean and carefully oiled or greased. Roofs and windows are periodically examined. The ventilating system is inspected and it is the duty of one man to maintain proper ventilation in each building. The skylights are kept cleaned and those which are expected to open, do open—but I am getting off my story, because the maintenance and construction department of the Ford Motor Company does not have charge of the cleaning or the factory service. These are taken care of by distinct departments.

In general, one is impressed with the ease with which most of this work goes forward and the small amount of clerical work which seems to be necessary to insure its continuance. Of the 2,900 men in the maintenance department, less than 10 of them are major executives and less than 10 general foremen. Upon inquiry as to the number of emergency repairs, the answer was: "We don't have them very often; we can't afford it; it costs too much to stop our process line. We usually catch breakdowns before the damage is done. It is our job, you know, to *maintain* the production of machinery."

Each order is made out in triplicate and each order blank contains the following information: Serial number of the order, the account number, the department charged, the factory work order number, the quantity wanted, detailed patterns and forging number. There are also spaces to be used for ordering castings, the number wanted, the kind of material, the pattern number and delivered to, the date, requested by, department location and location of jobs, with a space for the superintendent's o. k., approval and assignment. An order properly filled out is shown herewith.

Individual maintenance departments are maintained in B building, steel mill, the pressed steel building, the Spring and Upset building, the blast furnace, the motor building, foundry and foundry machine shop, power house, open hearth plant and the glass plant. Each of these departments is under the superintendent of the particular building in which it is located. Each has a group of workmen needed for the particular work done there.

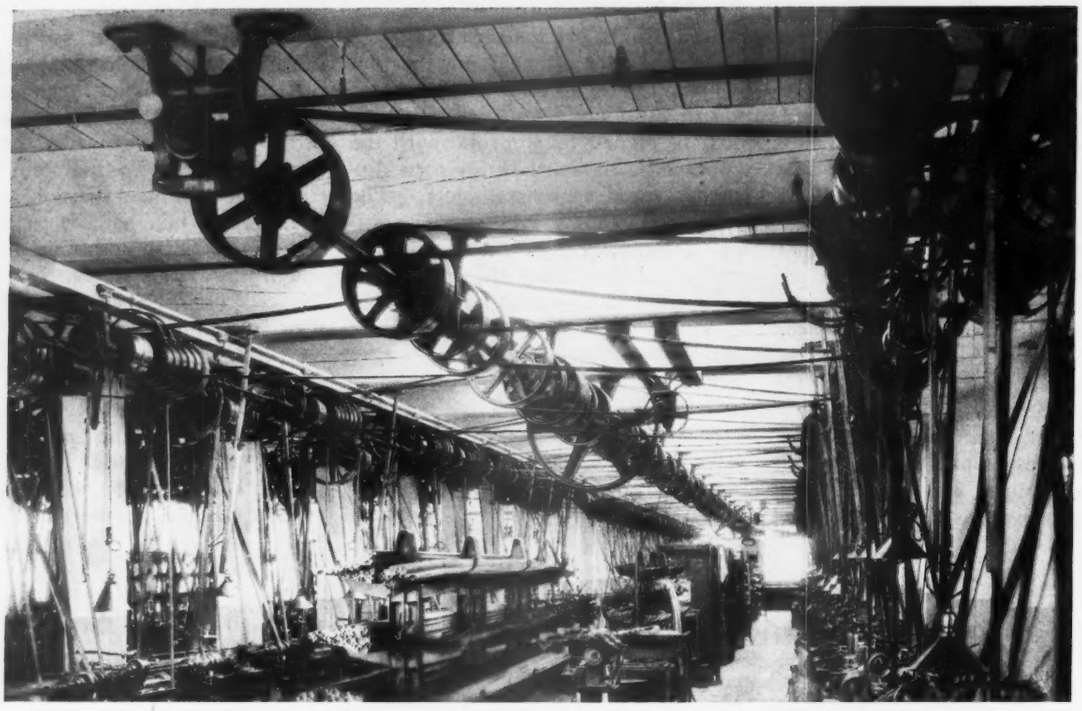
The buildings, the building department, machinery and equipment are inspected frequently, sometimes daily, by men assigned to this work. The machinery is generally inspected by the man assigned to do the oiling, although the foreman has the direct responsibility. The buildings are watched for overloading, vibration, jar and shocks, heavy machines on light floors, overloaded balconies, excessive amount of traffic, dampness, corrosion or abrasion, extreme heat or cold, electrolysis, improper use of material or machines, excessive humidity, or the presence of anything which will cause corrosion or decay.

Nearly all the machine tools in the Ford plant are electrically operated so that the inspection of electric motors and their drives, starters and other controlling mechanisms forms a large part of the maintenance work in the production shops. Here the electrical equipment is watched for insulation breakdowns, abrasion, dust and gases, corrosion, ventilation of elements as in the case of arc lamps, heavy overloads due to increased production or improper methods, lack of use, deferred maintenance, wrong starting, insufficient cooling, bad lubrication or alignment, weak or poorly designed foundation, improper care of bearings, and the various things which are likely to cause failure.

In the same manner all of the pipe lines, valves, outlets, supports, and so on, are watched in the water, steam, heating and cooling lines. The power tunnels are regularly inspected and kept free from moisture and excessive dust. Proper temperatures and ventilation, although cared for by the factory service department, are also checked by the maintenance department.

To merely enumerate the multitudinous duties of the maintenance department and the manifold jobs that they are called upon to perform would require, for merely listing, all of the pages of this issue.

Suffice it to say, therefore, the maintenance department has under its control virtually everything that is left over after the duties of the various production departments have been assigned.



Lineshaft installations require regular inspection, retightening and checking alignment

What to look for when INSPECTING *Lineshaft Drives*

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MUCH has been written and a great many rules have been formulated regarding the inspection, maintenance and replacement of lineshafting, pulleys, hangers and belting.

No attempt will be made in this article to give engineering data on shaft sizes, speed calculations, and so on, because manufacturers of the various equipment usually supply such information in their literature and a number of magazines (INDUSTRIAL ENGINEERING in particular) have published helpful tables. It is intended herein to give some general facts and information which will enable the average shop man to care for and operate, or make the necessary changes that will enable him to operate his transmission equipment on a reasonable, commercial basis.

Inspection — Periodic inspections, although at times these are likely to drift into routine reports based upon casual observations by the inspector, are, however, an essential in providing for continued efficient operation of equipment. To overcome the danger of neglect during routine inspections, the superintendent in charge may designate occasionally a different man and thereby obtain reasonable assurance that one man will pick up a weak spot which another may have missed.

Belts—Such inspections should include the condition of belts, whether too oily or too dry, too tight or too loose, the examination of joints, and the detection of cracks or other possible defects. If it is found that the machinery is throwing oil on a belt, the trouble should be investigated and eliminated immediately. If the belt has picked up an appreciable amount of lubricating oil or if the surface seems hard or dry, it should have a careful treatment to put it in proper working condition. The instructions for such treatment may be obtained from any reliable belt manufacturer. A good leather belt of the average size is worth more money than most people imagine; a little money spent on its upkeep will be repaid many times over, due to its prolonged life and more efficient operation. It is quite possible to get from 20 to 25 years of continuous service from a good leather belt if it is given reasonable care.

When installing new machinery, care should be taken to secure pulleys of sufficient diameter and to otherwise install the equipment so that belts will not be overworked or have to be so tight as to cause bearing trouble or excessive strain. In this connection, the center-to-center

distance of shafting is of most importance.

In the absence of printed tables or scientific data on this subject, which are generally available in an engineering handbook, a fairly safe rule to follow for determining center distances of shafting is to allow at least seven times the mean diameter of the driver and of the driven pulleys and to remember that a distance greater than this is preferable in most cases. This would apply either in the case where one line of shafting is driven from another parallel line or in the case where the drive is from the shaft to the machine. For example, if we have a 36-in. pulley on one shaft belted to an 18-in. pulley on another, the minimum center distance in feet is determined by adding 3 ft. to 1½ ft., which equals 4½ ft.; divide this by 2, which equals 2¼ ft., and multiply by seven, which equals 15¾ ft., the required center distance.

Two pulleys with a large variation in diameter should not be used together on a drive if it can be avoided because the belt slippage in such cases is likely to be excessive, due to the arc of contact on the smaller pulley being less than 180 deg. If it is impossible to eliminate this condition by interposing another shaft and set of pulleys, the situation can be helped by placing an idler pulley near the smaller pulley to press against the loose side of the belt.

It is sometimes necessary to have the speed of a machine a very definite number of revolutions per minute and at times this may be difficult to obtain, particularly if the pulleys used are of wide differences in diameter. Experiments have been made along these lines and for close calculations it has been found that the following is good practice: Make use of the regular formula $D \times r.p.m. = d \times r.p.m.$, but note that to the diameter of the pulleys add 70 per cent of the thickness of the belt, and, in addition, make an allowance of about 1½ per cent for belt ship or "creep" for normal conditions, and somewhat more if one pulley is considerably larger than the other.

Overloading belts is detrimental to their long life and economy. Where there is a steady load on a main drive, with large pulleys, three-ply leather belts 36 in. and 42 in. wide have given good results when loaded up to 100 and 110 lb. per in. of width. The average double leather belt, however, gives good results in the long run when the load is kept to 75 lb. per in. of width, while 60 lb. is a better average; for single leather belts, the load should be reduced to 50 per cent or 60 per cent of that allowed for double. Good economy is seldom obtained when the speed of belts exceeds 5,000 f.p.m. A better average speed is between 2,500 and 3,500 f.p.m.; these represent the more common commercial practices and they permit of an increase when necessary.

Pulleys—Pulleys should be inspected to see that they are in proper alignment and that they are running reasonably true. Both hub and rim clamping bolts should be inspected to see that they are tight. The face of the pulley should be examined to make sure that no serious wear is occurring. After pulleys have been in service for two or three months and are found to be tight on the shaft and otherwise satisfactory, inspection should not be necessary more frequently than every six months.

The selection of pulleys for replacement or additions to present equipment should have careful consideration. Pulleys should be used which, in stock sizes, are known to be safe at considerable speeds, say up to 5,000 f.p.m. (If higher speeds are required, it is well to so advise the maker.)

When machinery has been added to a point where belt and pulleys actuating the shafting are overloaded, there are usually two ways of providing for increased power transmission. One method is to increase the width of the belt, but a very good alternate is to increase the diameter of both the driving and driven pulleys, leaving the belt width the same. The larger pulleys naturally increase the speed of the belt, the revolutions per minute remain the same, and this greater belt speed proportionately increases the power which the belt will transmit. However, do not let the belt speed exceed 5,000 f.p.m. It will hardly be necessary to say that, if the above procedure is followed, each of the new pulleys must be larger in diameter than the old by an equal

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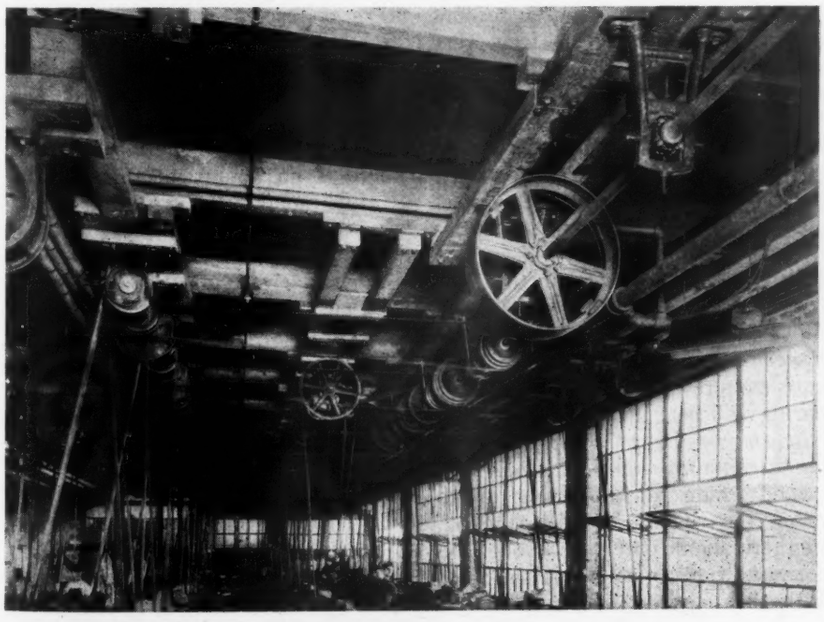
GROUP DRIVE with pressed steel pulleys and hangers. When lineshafts, pulleys and hangers are erected they should be gone over frequently to retighten bolts and lagscrews until the installation has "set."



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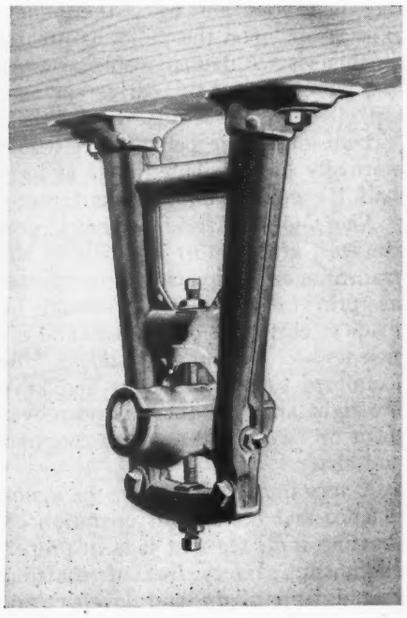
DROP HANGER of the pressed-steel, four-point adjustable type. A similar type can be seen in the installation shown at the left, supporting the overhead main-line shafting in a modern machine shop.



percentage; in other words, the pulley ratio should remain constant.

The regular stock pulley sold by most manufacturers is capable of taking care of a considerable percentage of average factory and miscellaneous work, although this is less the case today than it once was because of the heavier duty constantly demanded of machines of all classes. There are, however, occasionally really heavy jobs, such as on stone crushers, drop hammers, air compressors, idlers, and so on, which require extra-heavy or special pulleys and in which service the commercial stock pulley cannot always be expected to stand the racket. And, generally speaking, it is money in pocket in the long run to select a pulley of the most reliable make, whether for stock or a special job.

It may be worth while to mention at this point that the duty which imposes the most severe strains upon pulleys is where they receive intermittent and shock loads. Many pulleys have failed in service at what does not appear to be an excessive horsepower requirement, but where investigation has developed the fact that the load was uneven in character and also that the pulley, belt and shafting were subjected to what amounted to a never-ending series of blows or heavy vibrations.

It is often thought that the idler pulley is subjected to light duty. Generally this is not so. Idler pulleys exert necessarily a considerable pressure upon the belt with which they are in contact. This pressure is, of course, exerted equally upon the pulley face and is confined to one point of contact, or in other words the belt does not warp the pulley. The strain upon the pulley is greater in this service than it would be were the pulley acting as a driver or as a driven member, because under these circumstances the belt contact would normally be distributed over at least half the entire pulley circumference.

Shafting—Shafting, perhaps, gets the least attention of any part of the transmission equipment. Inspections, as previously indicated, should be made to ensure its correctness and efficiency. Couplings should be examined to see that bolts and keys are tight and that there is no movement or "working" between coupling and shaft.

A very important item in the maintenance and economical operation of shafting is to see that it is in proper alignment. Every line of shafting should be straight and level. Any good millwright can line a shaft with a good spirit level, a few plumb lines and a good piece of fishing line or a fine wire. A shaft with one or two of its hangers out of line is subjected to a continuous bending and rebending action and is sooner or later likely to crystallize and break. Such misalignment is also a source of power loss. If shafting is kept in line and level and is properly supported, there will be no great power loss from any well made bearing.

Hangers—One manufacturer of shafting gives the distance between hangers for the various sizes of shafting as per the following table. This list appears to be a good guide for general factory work, but is not intended for headshafts:

Diameter of Shaft in Inches	Distance Between Hangers in Feet
1	5½
1½	7½
2	9
2½	10
3	11½
3½	13
4	14

The inspection of hangers should include the examination of the bolts or lagscrews which hold the hangers to the footing pieces or building structure. These bolts are likely to become loose shortly after being put into use due to various reasons. Bolts take a permanent set after being under stress, and bolt heads, even if washers are used, imbed themselves in a wooden supporting material. The supporting structure as a whole changes. Wooden joists and footing pieces shrink and even a steel superstructure may alter to some extent because of additional loads or from expansion and contraction on account of temperature changes. It is very important, therefore, that these bolts be given inspection and care until the whole building becomes "set" to prevent movement on the part of the hangers which would throw the shaft out of proper alignment with consequent damaging results to the entire equipment. The four setscrews (in a four-point hanger) supporting the shaft bearing should be set up just sufficiently tight to prevent movement between the bearing and frame. If these setscrews are too tight, the bearing will heat up quickly.

Bearings—Ring oiling bearings should contain a sufficient amount of a good grade of lubricating oil to permit the ring to dip into the oil, but there should never be enough oil to cause it to overflow at the ends of the bearings.

Collar end bearings, where collars are needed, have a loose cap over the collar which permits the adjustment of the collar without disturbing the position of the bearing proper. All hanger bearings, of the ring, chain, or wick-oiling type, after being in use a year, should be taken out of the hanger frames, old oil and any accumulation of foreign matter cleaned out, and the bearing surfaces of both the box and shaft examined to see that such surfaces are in good working order.

This inspection and cleaning should be done periodically, the frequency depending on the nature of the work and the condition of the room or shop where the shafting is installed. If there is a considerable amount of dust and grit in the air, it will naturally be necessary to give more frequent attention to shaft bearings than when there are but few floating particles of a gritty nature. Anti-friction bearings should be periodically inspected for adjustment and lubrication. Such bearings, although they may be properly installed, are subject to wear, or the internal mechanism may shift from its proper alignment. A ball or roller bearing is not efficient if operating with worn parts or if operating with parts out of adjustment.

Group vs. Individual Drive—Finally, it is quite reasonable to assume that the question will arise as to the advantages or disadvantages of mechanical transmission appliances compared with direct motor drives. This is an old question and one which has attracted a great deal of study and investigation, particularly during the last few years. Prominent engineers connected with some of the largest manufacturers (not interested in transmission equipment except as users, however) have stated that the individual motor drive is often overrated, and, in many cases, abused. There is no doubt but that the individual motor drive is often a necessity, and, indeed, the only proper drive to use. Individual motor drive is particularly advantageous for isolated machines and for machines using a steady load of over 20 hp.

Disinterested engineers have made reports showing that it costs from 50 per cent to 60 per cent more to equip the average factory with individual motor drives as compared with group drives. The operating cost has been shown to be sometimes 40 per cent to 50 per cent more for the individual drive as compared with the group drive.

Announcing the Winners in the "BETTER SYSTEM IN USE" *Contest*

For the best three answers to Edson's letter on the inspection, maintenance, and replacement of equipment in industry

THESE SELECTIONS *were based on the method of presentation, general interest and applicability to other plants, completeness of detail and adherence to the subject matter. The best three answers to Edson's letter appear in sequence in this issue*

The FIRST PRIZE *of* $50 *is awarded to*

K. D. HAMILTON

Plant Engineer

Geo. E. Keith Company, Campello, Mass.

This is a review of a system that has been in operation for at least ten years. The Geo. E. Keith Company employs approximately 5,000 people in plants of a diversified nature as refers to product and equipment.

EDSON'S or in fact anyone's position is easily understood when the Old Man takes that attitude in advising him to work out a better system and concluding with "See me."

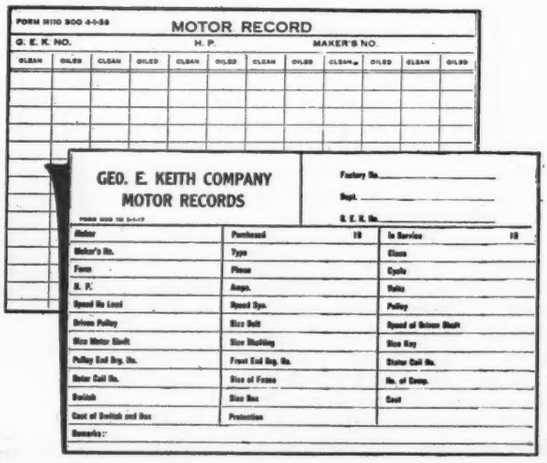
Inasmuch as these columns in Industrial Engineering are reserved for inside information providing that you do a good turn to the other fellow when he asks a question that you can answer from your experience, I believe, therefore, that the system in operation at the plant of the Geo. E. Keith Company, Campello, Mass., will interest, not only Edson, but the Old Man as well. It is as follows:

1. (*a*) A definite inspection and maintenance system is in control of substations and distribution of electrical service. This comes under the immediate jurisdiction of the chief electrician and his assistants. Transformers, generators and other major electrical apparatus are inspected daily, weekly and monthly depending upon their importance. Generators are checked for brush conditions, commutator operation and lubrication. This control also applies to motor generators, direct-current and alternating-current motors. Such equipment as transformers are serviced once a month. Fuses, oil switches, automatic controls, elevator boards and main switch channels are checked for operation and repairs once each week.

1. (*b*) All motors in the entire plant are serviced by two men who specialize in this work, and it is their duty to clean and oil all of this apparatus independent of the electrical supervision. These men are provided with compressed-air machines, and a definite record is turned in each day stating the amount of work covered and the condition of the apparatus inspected.

1. (*c*) Mechanical power transmission comes under the jurisdiction of the boss millwright and his assistants, who maintain a rigid inspection of belting, shafting, pulleys, hangers, and allied equipment. Major belting is checked at least every other day for operating conditions; shafting and bearings are oiled and inspected at least once in three months; larger bearings at least every week and on special machines, every day. The shafting is aligned at least twice a year to insure the operation with the minimum amount of frictional loss.

1. (*d*) Plant structures, mechanical material handling and service systems are under the constant supervision of the safety department as well as other branches of the mechanical department having charge of the service machinery. The safety department in fact, exercises



MACHINERY DATA CARDS used at Geo. E. Keith Company measure 3¾x6 in. and may be obtained from any firm that specializes in filing systems, etc. Form M53 is the "Motor Record" card which identifies a motor and its service. The reverse side is used for repair data, Form M110 "Motor Record" card supplements Form M53.

general supervision over all equipment from the point of view of accident prevention and in this inspection work they frequently find items which should be called to the attention of the responsible foreman. Regular plant inspection is held at least once a week for housekeeping methods as well as plant repairs. Major repairs and inspections are made every month for recommendations, which are compiled in a report to the management for consideration.

2. The findings of these various committees are tabulated daily wherever possible on system cards and records. These findings are brought to the attention of the plant engineer in charge who compiles reports at frequent intervals for the management. A system of machinery data cards is maintained referring particularly to electrical apparatus indicating nameplate data, driven loads as well as other characteristics which are necessary for the reordering of spare parts. Tabulations are made of elevators, conveyors, power equipment, buildings and other major apparatus compiling standard data which is required in the general operation of a plant engineering department. This information is kept in loose-leaf books for reference.

3. A few of the common-purpose cards for record purposes are shown in the accompanying illustrations.

4. Definite inspections are made at least once in three months to determine major repairs and replacements. These items are tabulated for executive consideration and wherever possible are incorporated in the annual report with estimated costs for budgeting the entire year's expenses for major improvements or replacements.

P. S. The Old Man was right.

K. D. HAMILTON.

Plant Engineer,
Geo. E. Keith Company,
Campello, Mass.

The SECOND PRIZE *of* $25 *is awarded to*

HENRY F. SCOTT

Plant Engineer
Dennison Manufacturing Company
Framingham, Mass.

Taking together all the advantages of an inspection system, it is evident that by its means, the plant engineering department will be able to improve its services to production in industrial plants.

IF I WERE to answer the question asked in the P. S. of Edson's letter, I would tell him not to worry about the "Old Man's" attitude, but get his inspection system organized and furthermore, extend it to cover manufacturing facilities or the "Old Man" will still be one leap ahead.

An inspection system should be a staff function organized to: (*a*) maintain quality of product and safe operation, (*b*) maintain continuous operation of manufacturing and service equipment, (*c*) reduce the cost of up-keep to a minimum.

At the Dennison Manufacturing Company plant at Framingham, Mass., the inspection is made by, or under the direction of, a staff department in the plant engineering division. From actual experience it is apparent that the benefits obtained are in direct proportion to the confidence in the inspection system and co-operation established in the minds of those in charge of operating the equipment in the plant.

In general, the inspection system is outlined in detail on fifty or more forms, covering all classes of equipment. These forms are not, at the present time, uniform in size or character, but an attempt is now being made to standardize them which will increase their value as a permanent record.

All inspections are made at definite intervals, and followed by means of a perpetual calendar. When the time arrives for an inspection to be made, an inspection card is removed from the file and put in its proper place to come out on the next inspection date.

1. (*a*) The inspection of power equipment and distribution is supplemented by the services of an outside inspector. Such a plan is particularly desirable when equipment for testing is not available and where technical experience of the local staff is not sufficient to detect the more obscure faults which may occur.

1. (*b*) Inspection of motors and control equipment is carried on by a supervised inspection, covering, at the same time, the cleaning, oiling and minor repairs. Electrical inspection also includes verification of record for machine speeds and tests of motors for overload and speed control.

1. (*c*) Mechanical power transmission is not a large problem in this plant. Only superficial records are kept of belting and inspection orders are performed by the belt repair department.

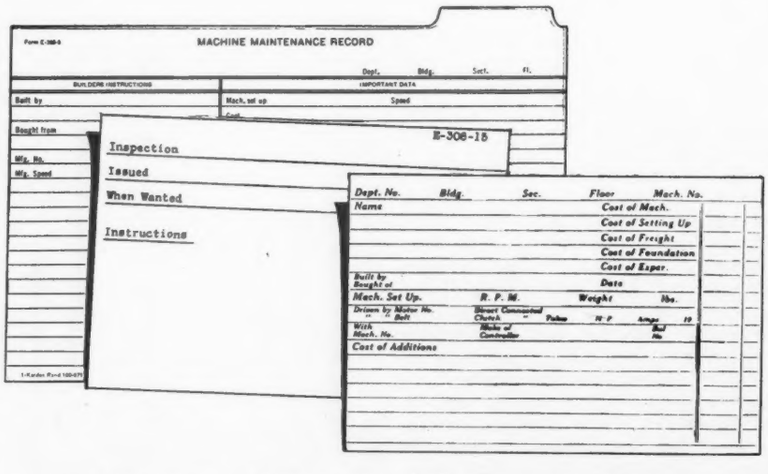
1. (*d*) Plant inspection includes the condition of buildings, stairways, structures, floor loads and all conditions which relate to fire prevention and safety to employees. Inspection of material handling systems are made to anticipate repair work, but also to direct the oiling and cleaning.

The most important inspection of service equipment is for elevators. Here we have weekly, monthly and quarterly inspections. The weekly inspection is made in conjunction with the elevator operator. The more complete monthly inspection covers conditions of ropes, elevator machine and safety equipment. The quarterly inspection is made by a representative of an elevator manufacturer in the presence of the department inspector and serves as a check upon the local inspection.

Heating equipment is inspected at the beginning of the heating season and the control of the heat, to provide proper temperatures in the manufacturing department, is directed by the inspection department.

Steam traps, reducing valves and compressed air systems are inspected monthly, and more frequent attention is given where necessary, to maintain at all times, proper working conditions in the manufacturing departments.

In this plant the machine inspection



MACHINE MAINTENANCE, INSPECTION AND PERPETUAL CALENDAR inspection cards used by the Dennison Manufacturing Company to keep tab on the condition of their equipment.

in producing departments is one of the most important branches of this work. Regular machine inspections include preventative repair work, improvements necessary to maintain quality, supervision of oiling and cleanliness.

The inspection department directs the engineering division regarding supply parts to be carried in anticipation of repair work.

2. It is the duty of the "Plant Engineer" to see that the work recommended by the inspection department is justified, and that the cost of the inspection system is comparable with the advantages to be gained.

3. In carrying on the work in the inspection department, use is made of the records which are kept for other purposes in the engineering division. For instance, the repair expense of each piece of equipment is added to a machine card together with the original cost and the cost of any additions or alterations. The inspection department refers to these cards when making their inspections and this information is a guide to them in recommending rebuilding or replacement. To follow the completion of inspection orders, the inspection department keeps a copy of the orders issued until the record is entered on the machine card.

4. The actual need of replacement does not always originate in the inspection department. More often, the request comes from the manufacturing department, or is brought about by a technical study of equipment to reduce costs. When excessive repair expense is shown on the machine card, the inspection department studies the machine to determine if the repairs can be reduced by re-designing the equipment, or by substituting different repair materials.

When an inspection department is first adopted the repair expense may for a year or more show a decided tendency to increase, but the experience in this plant has shown that after the first year the repair expense in relation to total investment has been lower than it was previous to the inspection system. With the operation of such a system it is very easy to extend mechanical supervision to oiling and cleaning.

HENRY F. SCOTT.

Plant Engineer,
Dennison Manufacturing Company,
Framingham, Mass.

The THIRD PRIZE *of* $10 *is awarded to*

F. M. GIBSON

Mechanical Engineer
49 South Second St.
Brooklyn, N. Y.

This system represents what is left of a very highly complicated method of inspecting the equipment tributary to production. It was devised to reduce the amount of unnecessary writing by the employees where too much non-essential information was carried as a record of the condition of the equipment.

IN THE postscript of his letter to Practical Pete, Edson asks if the Old Man was right. He was right. All that the Old Man wanted was some detailed information that would indicate, that Edson arrived at his decision concerning the necessity of spare parts by an intelligent review of existing conditions, or from detailed records of past performances. He received a hackneyed generality about past experience and mass production. Sensing what was wrong he put his finger on the sore spot, and Edson howled.

Edson said that he had had past experience. If so, he should know better than anyone else what inspections should be made, the frequency of inspections and the essential facts to be recorded.

There is no reason why he should not start his system immediately. Apparently, he wants to wait a month or so until some people, who know nothing about his plant, tell him how to run it. What type of equipment has he, and what is the size and character of the load? How many hours a week does the equipment operate, and what type of people operate the equipment? How great is the financial loss due to shut-downs as compared with the interest on money invested in spare parts, and are the spare parts standard stock carried in a warehouse around the corner, or must they be secured on two months delivery from the manufacturer? What are the atmospheric conditions as to temperature, moisture and dust?

New systems of inspection records generally record too much non-essential information, involve too many printed forms or cause too much writing by employees. The writer in one particular instance overcame the last two mentioned items with the following system:

Thirty-three mechanics, each responsible to the master mechanic for the maintenance of a particular kind of equipment, were required to make a periodical inspection and report. Some made inspections weekly, some monthly and some (on structures) every three months.

Each inspector was provided with a holder (a duplicate being given to the master mechanic) made of two thicknesses of ⅛-in. cardboard glued together. This holder is shown in an accompanying illustration.

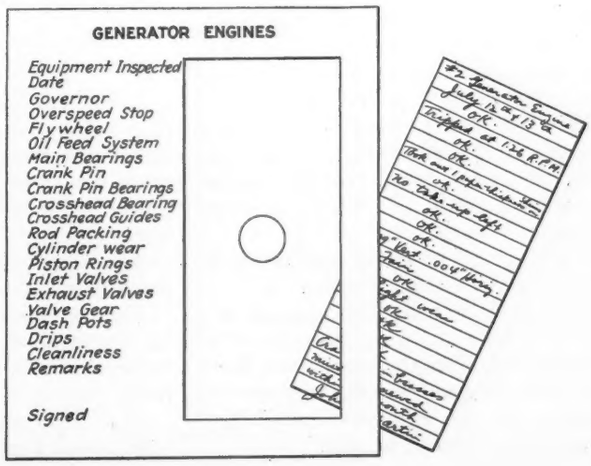
The mechanic would insert a card in his holder, write the answers on the card to the master mechanic, who would insert the card in the duplicate holder. Any item reported unfavorably was given to a clerk who typed the report on that one item on a loose leaf page about 3x4 in. and inserted it in a loose leaf book held by the master mechanic; a duplicate was placed in a similar book held by the plant engineer. When the reported item was corrected, the master mechanic wrote the data of completion on that particular page. He sent it to the plant engineer who then returned it to the master mechanic, and at the same time tearing the duplicate sheet out of his own book. By this means the master mechanic had a ready list of work to be done and the plant engineer had information on the condition of the plant.

The mechanic had to secure authority from the master mechanic to perform any repairs outside of recognized routine repairs.

This system has its weak points but, for our general purpose it meets our requirements and this is all any system is expected to accomplish.

F. M. GIBSON.

Mechanical Engineer,
49 S. Second St.,
Brooklyn, N. Y.



EACH INSPECTOR is provided with a cardboard holder similar to this. The inspection cards are standard 3x6-in. stock. The holder is made up of two cardboard sheets with openings for recording data, and for removing the card.

H. S. RICH *comments on*

WIND AND WHISKERS

THAT sensible little talk on the contents page of the January issue of *Industrial Engineering* struck a responsive chord in my mind, for when the plant engineer gets some wholesome resolutions well cooked up before the snow flies, wintry storms make fewer dents in his pet plant.

Whiskers, did you say? Yes, there are lots of them around many plants, but not on the engineer or chief electrician. Look at the whiskers of dust, dirt, and lint adhering to the beams, walls, ceilings, machines and so on.

What's the matter with doing a little house dusting during the nice days, and perhaps painting and whitening up a little? It aids reflection a lot, and will cut down on your lighting bill.

Buildings and Plant Structures

While the weather is still good, have the roofs repaired; if these are "tin," have the leaks soldered up, and more or less good paint applied to keep them from rusting.

If the roof is of slate, pull out the broken shingles and do a little honest-to-goodness repairing with a few new ones.

Look to the gutters. Water must go somewhere, and keeping it off to one side is more comfortable for workmen than having a Niagara pouring down over the door every time one passes in or out. Church is the place for baptisms—not shops.

See whether the roof timbers need bracing; a heavy, wet snow may make the roof sag dangerously. One plant in mind did a lot of timber bracing on one stormy day, and even though there were then doubts about its safety, it came through unharmed. Another plant did no bracing and the roof and walls fell, killing a large number of men.

Tighten up or renew guy cables to stacks and conveyor towers.

When wet snow flies around and freezes such structures may be overloaded and when the wind blows hard, it does no good for the engineer to appear on the scene and exclaim appealingly, "Peace, be still."

If the stack or tower wishes to fall, just waltz out of the way, or it may dent your brainy dome and stop proceedings for a brief spell, while some rapid-fire cussing is being earnestly practiced.

Put in a few panes of glass; use up a little putty; fasten some sashes in place; and otherwise make a few attempts to keep snow and wind out, and the heat in.

Have enough snow shovels on hand. Paths around the plant must be cleaned. If there is a long sidewalk in front of the plant, or long paths in the yard, try rigging up a plow in front of an electric tractor and watch it do the work of a dozen men in less than an hour. Save the men for needed jobs; let machines do the hard work whenever possible.

One plant engineer built a rough board plow in about an hour, and had it push the snow from walks hundreds of feet along in a short time. Two men ran the tractor.

Pipe Lines and Other Equipment

Cover exposed water and steam pipes. Let me whisper this: "Water sometimes freezes, and steam sometimes condenses." Does not the engineer know it? Yes, but there are many other things to be attended to, and he sometimes overlooks some of these points.

Motors placed outdoors should have covers put on them every night; these covers should be securely tied down during wintry weather.

Coal conveyor pits should have board coverings to keep out the snow. These may be arranged so that the conveyor or bucket elevator can remove the board cover and replace it as needed.

Put a few extra boards and a door or two on storage sheds containing firebrick, acids, coke, lime, sand, etc.; otherwise much time will be lost in trying to get at needed material that is frozen solid.

Sand and soft coal piles are more easily worked on freezing cold days when a steam pipe is installed under the pile. The pipe must be slanted to allow drainage; otherwise it will freeze up. Have the controlling valve inside a near-by building.

Remember, too, that a hot water hose does wonders when snow and ice are to be cleaned away from doors, hydrants, hose houses, drains, and other places.

Personnel and Weather Predictions

Stormy winter days often make the electrician feel blue, from both rage and low temperature, when he finds that a conductor or two has fallen across the yard, right in the way of the switching engine. What happened? Oh, only a splice broke, or a staybolt gave away, due to a careless job done on a nice summer day, when no one had ice-laden cables on their mind.

Now, really, don't icicles look pretty the whole length of outdoor conductors, on a squeaky cold day? Sure, they do! But if you want to see something prettier, look at the electrician's face. He has a mean job ahead of him. Some department is shut down: so, "On the job, boys."

In other words, outdoor conductors, strain insulators, splices, brackets and braces should be extra secure to withstand the weight of hundreds of pounds of ice and wet snow.

Last of all: Play safe! Do not depend on anybody's weather predictions. When winter comes, nobody knows what it will be like.

Many such predictions are plain bunk; and so are some of the slipshod preparations made for winter.

ELECTRICAL SERVICE

Around the Works

For this section short articles describing ideas and practical methods devised to meet particular operating conditions are invited from readers. The items may refer to inspection, overhauling, testing, and emergency or special installations.

Loose Motor Lead Caused Excessive Current Demand

TROUBLE in one of our d.c. motors recently caused the fuses to blow repeatedly. The coils of this machine when tested were found to be in good condition and they did not seem to have been affected by an excessive amount of current.

Later it was discovered that the negative motor lead made a poor contact with the negative brush lead and one side of the shunt circuit. After these connections were tightened, however, the motor ran normally. In this case, the continual heating of the loose contact would have soon come to our attention.

Just why the motor should, in this case, take more current under these conditions and not increase its speed was not at first understood. Later it was concluded that the poor terminal contact reduced the voltage across the armature and caused an excessive current to be drawn from the line, blowing the fuses.

As a result of our experience with this motor, I believe other operators will find that loose or poor contacts are some times causing fuses to blow.

W. E. WARNER.
Shefford, Bedfordshire, England.

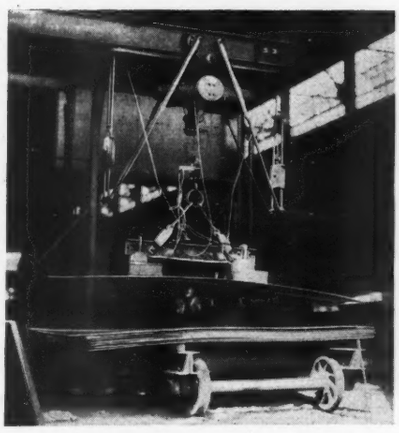
Two Lifting Magnets Facilitate Handling of Steel Plates

THE handling of steel plates in a plant, which makes pressed steel car ends and similar products, was greatly facilitated and simplified by employing a pair of lifting magnets.

The two rectangular lifting magnets, which are shown in the accompanying illustration, were supplied by the Electric Controller & Mfg. Co., and are hung from a spreader beam which is itself suspended by a cable from a monorail hoist.

As a means of keeping the magnets in line and of stopping all swinging of a lift after but one or two swings, two arms have been extended out from the monorail hoist parallel to the track and, from the two ends, vertical slides are hung and rigidly braced. On each side a counterweight is suspended from a cable which runs up over a pulley and down at right angles to the spreader beam supporting the magnet.

In this case, the plates are charged into a heating furnace one at a time. The operator, who controls the movement of the plates, is located in a control room opposite the end of the furnace. During the movement of the plates, it is claimed that no floor man is needed to steady the plates as they are being carried to the charging platform.



HOW TO CONNECT a pair of lifting magnets to prevent swinging

* * * *

How to Determine Accuracy of Watt-Hour Meters

THE accuracy of watt-hour meters should be checked at regular intervals if reliable readings are desired. In these meters the speed of the rotating element is proportional to the load carried by the meter. Therefore, to test the accuracy of the meter it is necessary to determine whether the speed of the disk is correct for the load applied.

Constants—The energy represented by one revolution of the disk of a watt-hour meter is called the "watt-hour constant," and this is the fundamental constant in nearly all meter calculations. This number is usually stamped on the disk or some other part of the meter.

Where instrument transformers are employed, the meter commonly has a 5-amp. rating, the output of the current transformer secondaries at full load being 5 amp. The ratio of transformation is generally expressed as $n/1$. In this case the normal watt-hour constant of the 5-amp. meter must be multiplied by n. For example, with a 200-amp. transformer the ratio is 40 to 1, so the 5-amp. constant must be multiplied by 40. On high-potential primary metering installations where both current and potential transformers are used, the 5-amp. constant must be multiplied by the product of the current and potential transformer ratios.

In this way, using the 5-amp. constant as a base, the watt-hour constant of any size of meter can be computed. When the full rating in amperes and volts is stamped on the nameplate, the true constant will in all probability also be given.

On large meters the gear mechanism, or register, records the total energy in the line in such a manner that the dial readings must be multiplied by a "dial constant," which may be 10, 100 or some other number. This constant is not used in checking the accuracy of the meter, but is needed only in reading the index on the dial.

There is another constant with which under normal conditions the maintenance men are not directly concerned—namely, the "register ratio." Since many meters of a given type have the same full-load speed, regardless of their rating, the gear mechanism must be arranged to record the energy correctly. This ratio may be expressed as the number of turns made by the disk shaft to one turn of the fastest moving dial pointer.

Testing—A meter may be tested by means of a "rotating standard," which is simply a portable meter of known accuracy. To use this rotating standard, compare the revolutions of this disk with those of the meter being tested when both meters are connected to the same load.

As the factory maintenance engineer does not usually have rotating standards at his disposal, he must rely on his indicating instruments. With these and a stop watch he can make a thoroughly reliable test, unless there are large load fluctuations on the line. The method of carrying out this test is as follows:

A given number of disk revolutions are timed, preferably by means of a stop watch, although an ordinary watch may be used. Then the watt-hour constant multiplied by the number of revolutions equals the watthours. This result can be checked, after determining the power factor, by computing the watthours from the readings obtained from the indicating ammeter and voltmeter. Finally, the accuracy of the watt-hour meter should be determined only after taking the average of several tests. In all testing of this nature extreme care must be used in order to reduce the personal error to a minimum. N. COOK.
Paterson, N. J.

Grounded Fuse Clip Cause of Operating Trouble

DURING a severe electrical storm lightning struck the yard wires of an industrial plant. Shortly after the lightning struck, clouds of smoke were seen issuing from the pump house. A short investigation revealed that the transformer windings of a compensator in the pump house were badly burned and needed repairing. After the compensator was repaired it was found that one fuse ruptured every time the safety switch was closed.

It was eventually decided to disconnect the compensator, but the fuse in one phase continued to give trouble by blowing every time the switch was closed. An examination of the fuse block showed that current had been jumping from the head of a screw holding a fuse clip through the insulating compound to the steel box. This arcing was sufficient to weld the screw to the fuse clip.

J. F. MORGAN.

Hamilton, Ont., Can.

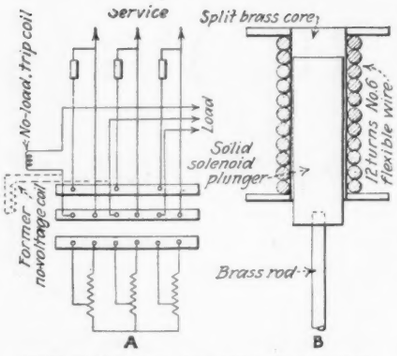
Method of Stopping Motor When Pump Loses Suction

ON SEVERAL occasions I have been called on to determine why certain centrifugal pumps ran dry. Usually I have found that one or more of the pump runners had been burned out. When these jobs were checked for the cause of the trouble, it was generally found that some foreign substance had lodged in the suction pipe of the pump. After the obstruction had been removed and the pump repaired, the unit would operate normally until the next time the pump lost its suction. To prevent the continual damage to the pumps, a no-load device was eventually worked out.

For the sake of illustration I shall refer to two pump units that I have in mind. They are driven by 30-hp. and 7½-hp. three-phase induction motors, respectively. On the pump unit driven by the 30-hp. motor the no-voltage release coil, connected as shown in the accompanying illustration at *A*, was removed from the split brass core of the solenoid and a coil of 12 turns of No. 6 flexible rubber-covered wire was substituted. This wire was wound on the core as shown at *B* and replaced in the receptacle on the starting box.

This new coil was connected in series with the load, as indicated at *A*, instead of being connected in parallel with the motor leads, as was the no-voltage coil. When the motor is loaded, a magnetic flux of sufficient strength is produced to hold the solenoid plunger in the running position. If for any reason the motor's torque is decreased, the magnetic flux in the coil is reduced, the plunger drops out, and the switch in the starting box is tripped to the off position.

The coil used in conjunction with the 7½-hp. motor has 33 turns of No. 8 flexible rubber-covered wire. It was found that the solenoids in both of these installations gave some trouble; so the laminated iron plungers were replaced with soft iron plungers 1 in. in diameter and 4 in. long, with good results. This type of coil is very simple and exceptionally easy to install, and proved its worth the first time it operated under actual running conditions.



THE PLUNGER IN THE SOLENOID drops and trips the control switch when the load on the motor falls off.

* * * *

Norco, Calif. PHIL D. COMER.

Construction Details of a Low-Water Alarm on Depth Board

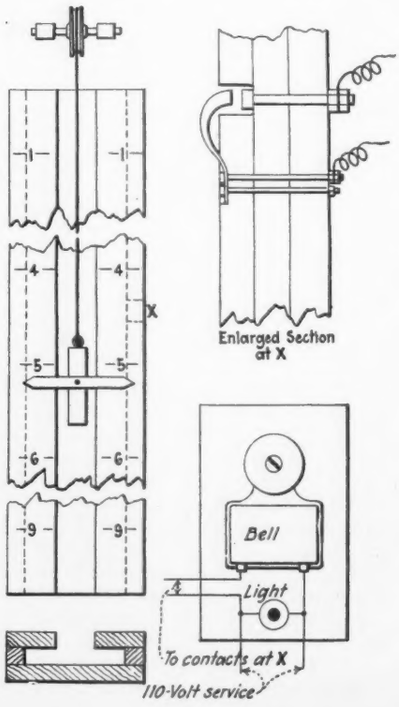
THE operators of both steam and hydraulic plants will find the low-water alarm shown in the accompanying illustration, a convenient and reliable means of warning when the water gage has gone down to a predetermined level.

At this level a contact, preferably possessing non-corroding qualities, can be set into the depth board as shown at *X*. One side of this contact is connected to one terminal of the alarm bell, which is often located at the switchboard, and the other contact on the gage board is connected to the 110-volt service line. The other terminal on the bell is connected to the service line. Ordinarily it is advisable to connect a pilot light directly to the service line as a means of indicating when the current is on or off.

As the indicator on the target moves over the contact at *X*, the circuit is completed and the bell rings. A parallel contact to indicate high water may be added to the circuit, if desired.

* * * *

THE ALARM BELL RINGS when the target passes over the contact at the low-water level.



E. J. MORRISEY.

Asst. Chief Engineer,
Western United Gas & Electric Co.,
Aurora, Ill.

Inspection of Electric Elevator Cables

THE condition of an electric elevator cable may often be revealed by a simple inspection; that is, by going slowly over the entire length of the cable carefully looking for worn places. Such inspections will occasionally reveal one or more defective conductors beneath the surface, which may be broken or partly broken. If it is desired to make periodical tests to determine the condition of a cable before trouble develops, the following method is a good one to follow:

On one end of the cable being inspected connect together all the conductors in the cable with one common wire, which should also be grounded to a water pipe or some other suitable ground. Next, connect a battery of several volts in series with a set of head phones, voltmeter, or whatever instrument is to be used for testing. Then connect one end of the test set to the ground and the other end to a feeler wire.

With the feeler wire touch each wire at the opposite end of the cable. As each conductor is touched, a deflection of the voltmeter, or a click in the phones, if phones are used, will be obtained when the conductor under test is continuous. But if there is a total break in one of the conductors, generally no deflection of the voltmeter, or click in the phones, will be obtained. The exception in some cases is due to the fact that the phones will click even though there is a break in a conductor, providing the circuit has sufficient capacity.

To find partial breaks follow the same procedure of testing, but after connections have been made, twist the cable back and forth slowly throughout its entire length, and if a partial break exists, the voltmeter will give an unsteady deflection.

ARCHIE L. FORGER.

Chief Electrician,
The G. A. Head Electric Co.,
Laconia, N. H.

NEW EQUIPMENT

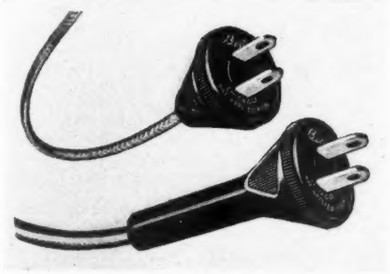
For Plant Operation and Maintenance

Industrial plant executives concerned with the selection and operation of mechanical and electrical equipment will be interested in these new devices which are designed to improve plant operation or reduce operating and maintenance costs.

Soft Rubber Plug

THE Belden Manufacturing Company, 2300 S. Western Avenue, Chicago, Ill., has added to its cord department a new soft rubber plug. This plug is ruggedly constructed of solid, soft rubber, and it is claimed that it can be dropped, knocked about or jumped upon without injury. It is shaped to form a convenient grip for the fingers when plugging in or pulling out, and is attractive in appearance. The insulating qualities make it well adapted for use in damp places and the soft rubber construction is of advantage on portable tools, household and office devices, etc. The plug is made in different shapes for various uses.

The Belden soft rubber plug is sold only as a part of Belden cord service



Belden Soft Rubber Plug

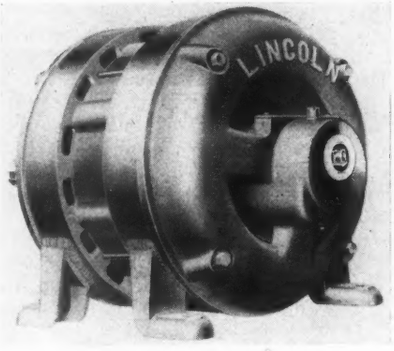
and is furnished attached to their many varieties of cords. Cords with plug attached are furnished in 10-, 20-, and 50-ft. lengths.

Self-Starting Motor

THE Lincoln Electric Company, Cleveland, Ohio, announce a new "Switch Start" motor for which several advantages are claimed. It is built in sizes from ½- to 30-hp. rating and for either two- or three-phase, 60-cycle current.

This motor is so designed that it can be started directly across the line, with the starting current below the N.E.L.A. requirements.

It is claimed that in the new "Switch Start" motor the operating characteristics, such as power factor, efficiency, maximum torque, temperature rise, etc., have not been sacrificed in order to secure low starting current. Tests show that starting torques of from full load to more than 250 per cent of full load, depending on the horsepower and speed, are possible without exceeding the



Lincoln "Switch Start" Motor

N.E.L.A. requirements for starting current.

On sudden, high overloads it is claimed that this motor also has a very high or maximum pull-out torque, which is of considerable importance in reducing the likelihood of the motor stalling on sudden overloads.

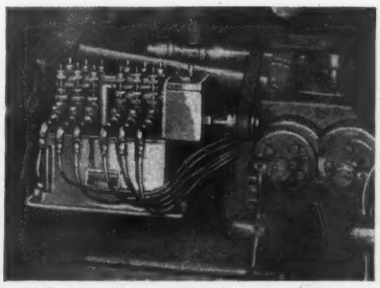
The new motor is of welded steel construction and is normally equipped with sleeve bearings, although ball bearings will be furnished upon request.

Force-Feed Lubricator

ADOPTION of its line of force feed lubricators to industrial manufacturing units has been announced by the Hills-McCanna Company, 2349 Nelson St., Chicago, Ill. The accompanying illustration shows a belt-driven twelve-feed lubricator installed on an 18-in. turret lathe.

Measured quantities of oil are forced to all main headstock and traverse bearings, thus, it is stated, saving operating time, oil waste or spilled, as well as eliminating possibilities of neglect in getting at certain bearings. The lubricator begins pumping oil when the

Hills-McCanna Force-Feed Lubrication with Twelve Outlets



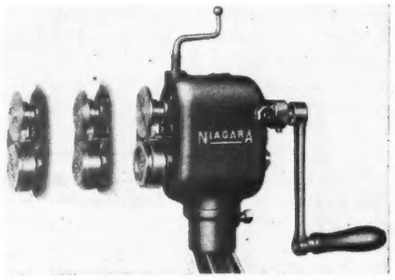
switch is turned on, and likewise stops when the machine is not in operation. Adjustment is permitted for feeding in amounts of oil to the different bearings in proportion to the needs of each; adjustments can be made on each pumping unit or feed independently of the others.

These lubricators are manufactured in various types of drives, such as belt, by reciprocating motion or individual motor, and in capacities dependent upon nature of machine to be oiled.

Turning, Wiring and Burring Machine for Sheet Metal

DEVELOPMENT of a combination bench machine for use on sheet metal or tin work has been made by the Niagara Machine Tool Works, Buffalo, N. Y. This unit can be furnished as a single-purpose machine or with sets of interchangeable rolls or faces. The illustration shows the burring faces at the left, the wiring faces in the center and the turning faces on the machine. The maximum size of wire accommodated is $\frac{5}{16}$ in. The maximum thickness of stock handled is 22 gage.

The frame is made of one piece and is extra heavy for rigidity and strength.



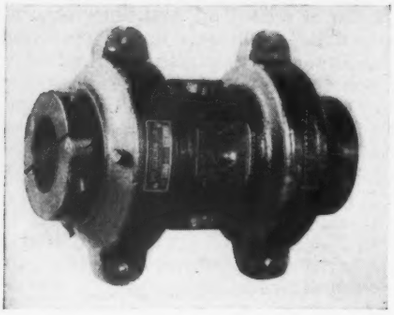
Niagara Combination Bench Machine for Turning, Wiring and Burring Sheet Metal

The bearings for the lower shaft are located in the solid metal of the frame. The upper shaft is movable at the front and is pivoted at the back and can be adjusted for variation in thickness of material. The gears are machine cut and are completely inclosed.

Split Ball Bearings

MANUFACTURE of the line of Lebanon split ball bearings for lineshafts and other applications where the placing or repair of single-piece bearings would involve taking down shafts and removal of pulleys or couplings has been announced by the Split Ballbearing Corporation, Lebanon, N. H. These are made in the dumbbell type for insertion in standard hangers or pillow blocks.

The components of a complete bearing are: a sleeve, bored to fit the shaft, split longitudinally and held together with suitable screws and dowels; a



Lebanon Split Ball Bearing of Dumbbell Type for Lineshafts

bearing shell, also split longitudinally and held together by similar means; a sufficient number of balls to fill the races; and spacers with which to separate the individual balls.

The ball races—four or eight, according to whether it is a single- or a double-row bearing—are made in halves, formed, hardened and forced into corresponding grooves in the sleeve and shell, and swaged into place to hold them securely. They are then form-ground to diameter and radius. The halves of both sleeve and shell are marked with corresponding numbers so that parts that are ground together will remain together. Instead of a cage to hold the balls apart, cylindrical spacers, smaller in diameter than the balls and having concave ends, are placed endwise between the balls.

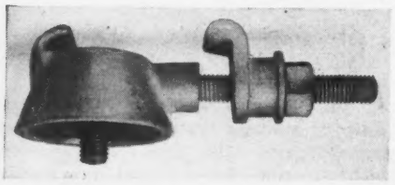
Bearings are made for all commercial sizes of shafting up to 2 1/2 in. Larger sizes are in preparation. It is stated that the bearings fit any standard hanger and may therefore be substituted for plain and babbitt bearings of lineshafts without extensive alterations or dismantling.

I-Beam Hanger

A NEW, insulated hanger for suspending mine and industrial trolley lines from I-beams has been announced by the Ohio Brass Company, Mansfield, Ohio. In reality this device is a combined hanger and clamp, which considerably simplifies installation. As will be seen from the illustration this hanger is installed simply by hooking it over the edges of the I-beam and tightening the holding unit. The standard size of hanger is made to fit I-beams or rails having a bottom width of 3 to 5 in. Hangers for beams of sizes other than those mentioned above can be furnished on order.

O-B Dirigo insulation is used in this hanger, and the shell and clamp are made of O-B Flecto hot-dip, galvanized iron.

Ohio Brass Insulated I-Beam Hanger



Steel Rule

THE Farrand Rapid Rule is a single piece of metal, nickeled steel, six feet in length and combines a number of desirable qualities normally considered impossible of attainment in a single measuring instrument. It possesses both stiffness and flexibility. Because of its unique structure it offers resistance to bending up to a certain amount of stress, after which it yields readily. This alternation from a relatively rigid state to an elastic one takes place all at once, following which the rule can be run into a coil with ease.

As a result, the rule can be carried in a specially devised holder which is a little larger than a good sized watch. When it is desired to use the rule it is merely necessary to press on the two brakes and the spring of the rule itself projects it from the holder. If the brakes are held down, the rule will shoot entirely free of the holder. It may be stopped at any desired point by releasing the pressure on the brakes.

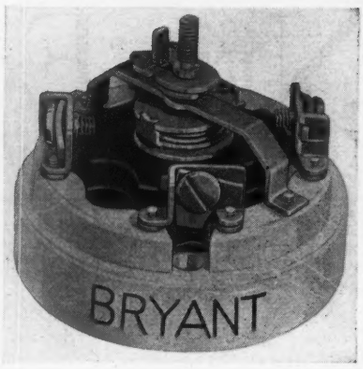
Farrand Rapid Rule

The rule itself is made of high grade carbon steel and can be bent at will without injury, so long as it is not bent beyond its natural arc of one inch diameter. It will, when released, spring back immediately into its perfectly straight shape. It is nickel plated except for the figures which are of colored metals, and are made integral with the body of the rule, affording the correct contrast in color. This combined with the relection of light gained by the concave surface on which the figures are placed, makes them decipherable in dimly lighted corners.

Heater-Type Switch

A NEW design of standard, heater-type switch has been announced by The Bryant Electric Company, Bridgeport, Conn. This switch, known as No. 6279, has reversible rotation with indicating handle and nickel-silver angle cover with raised, polished indications on a japanned black background. It is a solid-base switch, single pole, series-parallel, three-heat—operating high, medium, low, and off. It is rated at 20 amp. 125 volts, or 10 amp. 250 volts.

The center post extends the length of the switch with two bearings at the top bridge and in the bushing extending through the base, which it is claimed prevents the operating mechanism from getting out of line. The insulating pieces are of high dielectric strength. The switch driving dog is made of two rugged steel pieces clamped together. These in turn are rigidly attached to the center post. All escapement parts are made of 0.090-in. case-hardened steel. The switch blades are of heavy phosphor bronze with heavy brass contacts.



Bryant No. 6279 Heater-Type Switch

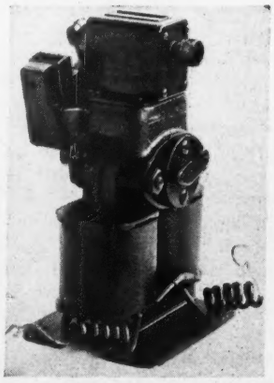
Magnetic Counter

MARKETING of a magnetic counter designed for operation on alternating current, has been announced by The Veeder Manufacturing Company, Hartford, Conn. These counters can be furnished for operation on 55, 110, or 220 volts.

The operating principles of these counters are the same as for the d.c. magnetic counters manufactured by this company. With both types the closing of a contact at each cycle of operation of the machine under observation energizes the magnet coils and actuates the mechanism that moves the number wheels.

A magnetic counter is essential where the counter must be placed at some distance from the machine on which the count is to be taken. A number of counters can also be grouped together in a central or convenient place.

According to the manufacturer, these counters are not recommended for a counting speed much in excess of 600 per minute.



Veeder Magnetic Counters for A.C. Operation

Constant Potential 8-Hour Battery Charger

FOUR models have been added to the line of HB constant-potential, 8-hour battery chargers made by Hobart Brothers Company, Troy, Ohio. These new chargers are rated at 150, 200, 250, and 300 amp. Each unit consists of a motor-generator set of unit-type construction. Ball bearings are featured, and all models embody a non-reversing, voltage-regulator winding.

The 150-amp. outfit has a capacity for handling twenty batteries, according to the manufacturer. The motor is rated at ¾ to 1¼ hp. The motor can be furnished for use on single, two- or three-phase a.c. or for d.c. The 200-amp. outfit will handle 25 batteries daily. Its driving motor is rated from 1 to 3 hp. The 250-amp. outfit will handle 30 batteries daily and its motor is rated at 1½ to 3½ hp. These three units furnish current at 7½ volts. The 300-amp. outfit, however, is furnished in either 7½ or 15 volts, and has a capacity up to 35 batteries daily; its driving motor is rated at 2 to 4 hp.

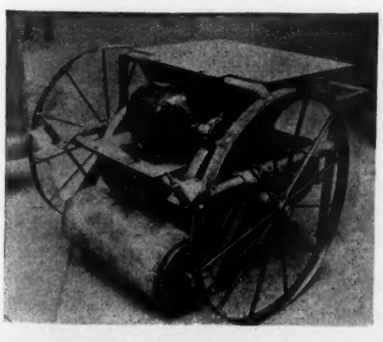
Box Car Loader

INSTEAD of conveying the material to be loaded into a box car, the new Sinden box car loader, built by Stephens-Adamson Manufacturing Company, Aurora, Ill., utilizes centrifugal force to throw the material to the desired position, the machine being made in a size a little larger than an ordinary wheelbarrow. This machine can be easily manipulated by one man and can be maneuvered inside of a box car. It is claimed that a box car can be loaded to capacity in 15 to 30 min., depending, of course, upon the nature of the material to be loaded.

The Sinden loader consists of a short, high-speed, motor-driven belt, fed by a hopper and mounted on running gear consisting of two large iron wheels. The carrying run of the 3-ft. belt is depressed into a circular curve, and the hopper is so placed that the material to be loaded drops through the bottom of the hopper and meets the belt traveling in the same direction, that is, downward. As the material falls on the concave side of the curve, it is forced against the fast moving belt and attains the velocity of the belt, when it is thrown off tangentially.

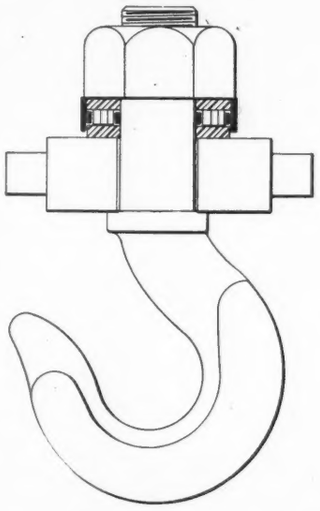
An important feature of the centrifugal loader is its low loading point. The top of the loading hopper is just 2 ft. 10 in. above the floor. The machine, which weighs about 730 lb., is operated by a 3-hp. 1,800-r.p.m. Westinghouse motor, equipped with a Westinghouse safety starting switch.

Sinden Box Car Loader



Crane Hook Roller Bearings

ANNOUNCEMENT of a new list, superseding previous sizes of Rollway bearings for crane hooks, has been made by Rollway Bearing Company, Inc., Syracuse, N. Y. Bearings of the old sizes can be furnished but the use of the new sizes is recommended wherever possible because of the large factor of safety and design which more nearly meets conditions found in operation. The accompanying illustration shows a hook with bearings.

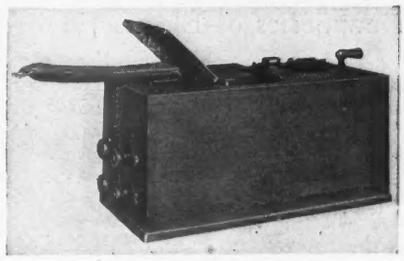


Rollway Bearings in Crane Hook

The rollers and thrust plates, it is claimed are made of high-chrome, high-carbon, alloy steel, heat-treated to give uniform hardness. A weather shed, which also serves as a lubricant retainer is provided to give the necessary protection to the bearing parts. The bearings are made in sizes to fit standard hooks with capacities from 5 to 100 tons. Larger sizes can be furnished on order. It is stated that with these bearings one man can easily turn a 30- to 40-ton load.

Ground Resistance Tester

A GROUND resistance tester for directly measuring the resistance to earth of all types of ground connections has been placed on the market by James G. Biddle, 1211 Arch St., Philadelphia. The manufacturer states that it permits rapid and accurate testing of all types of grounds and ground connections such as driven pipes, buried plates or strips, patented grounding devices, lightning arrester grounds, water pipes, ground wires, steel structures, and the like, among power companies, railroads, industrial plants and telephone and telegraph companies. The instrument is sold under the trade name "Megger" and is known as the "Megger" ground resistance tester.



James G. Biddle Megger Ground Resistance Tester

The instrument is direct reading in ohms by means of a pointer on a scale, and only one reading is required to obtain the actual resistance between a ground connection and the earth. The tester combines the alternating current potential drop method of ground testing with a direct-reading, pointer-type direct-current ohmmeter. After making three connections the observer turns the crank of the hand generator and reads the result directly on the scale. There are no adjustments or calculations to be made.

The set can also be used for testing ground connections directly against a water system having low resistance to earth; for testing two grounds in series if desired, or, for testing any resistance up to its range.

The instrument is said to be entirely free from errors owing to either alternating or direct stray currents in the earth or to polarization or electrolysis. By means of a special connection the instrument can be used to test the resistance of a given body of earth—that is, the resistance of the earth itself between any two points. This permits obtaining data regarding the potential gradient in the vicinity of an existing or proposed ground. Two instruments are available, one having the ranges 0 to 15 and 0 to 150 ohms, and the other 0 to 30 and 0 to 300 ohms. Higher ranges are available on application.

Motor-Generator Set

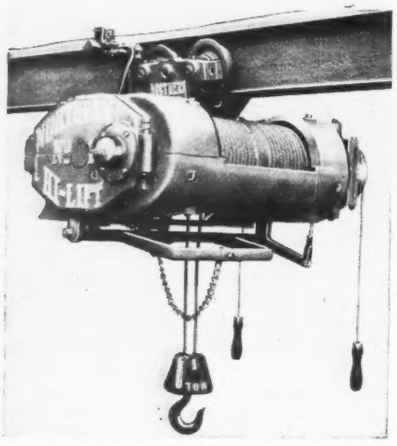
ANNOUNCEMENT has been made by the Electric Products Company, Cleveland, Ohio, of its line of low-voltage motor-generator sets designed to meet the latest needs of the electroplating industry.

These E-P generators are shunt or compound-wound, the percentage of compounding being governed by the conditions of the service. The reaction-type brush holders, which are of the latest design, are of sufficient size to insure low current density. The generator field ring is made of rolled steel, electrically welded to insure uniform distribution of flux.

New Series of Electric Hoists

THE new series of Hi-Lift electric hoists has been developed, it is stated, from the experience of the Northern Engineering Works, 210 Chene St., Detroit, Mich., in the design and manufacture of its line of Standartized electric traveling crane trolley. The new design, which has been made applicable to monorail use, combines, it is stated, high hook-lift with ruggedness, reliability, simplicity of construction, speed, and ease of application. The hoist, according to the manufacturer, permits the hook to travel close to the underside of the monorail.

The Hi-Lift hoist is built in a range of capacities from ½ to 6 tons, inclusive. The hoist can be furnished without a trolley for lug or upper hook suspension, with plain free-running I-beam trolleys, and geared and traveled by pendent hand-chain or with motor-traveled trolley of either floor controlled or cab controlled types.



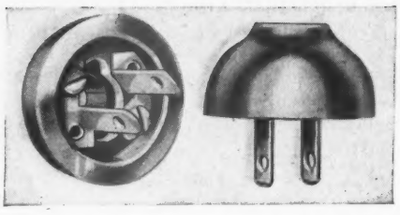
One-Ton Northern Engineering Works' Hi-Lift Electric Hoist

Hoist motors, which are of well-known make, with ball bearings, can be provided with either single- or variable-speed controllers for either a.c. or d.c. power. The Timken tapered roller bearings are grease lubricated. Both a mechanical load-brake and a motor shoe-brake are used.

Unbreakable Plug Cap

A NEW type of unbreakable attachment plug, which is made of rubber, is announced by The Cutler-Hammer Manufacturing Company., 611 Twelfth St., Milwaukee, Wis. Factories, repair shops and any users of small motor-driven tools or other electrical appliances should be interested in it because impact on cement or wood floors will not harm the plug or the finish on floor or furniture.

The plug, it is stated, is made of a high grade of rubber and is very light in weight. The terminals are fastened in a Bakelite strip embedded in the rubber base. Rivet and anchor construction hold the terminals to the Bakelite and keeps them from turning. Staked



New Cutler-Hammer Unbreakable Attachment Plug

screws prevent loss and save time in wiring.

When the plug is used with rubber cord a small dab of ordinary rubber cement placed between the cord and plug holds them firmly and permanently together and so serves to relieve the strain between them, according to the manufacturer. It is expected that this new unbreakable rubber cap will meet even greater favor than the steel Dreadnaught, which, it is stated, was also developed by Cutler-Hammer as the first unbreakable type of attachment plug.

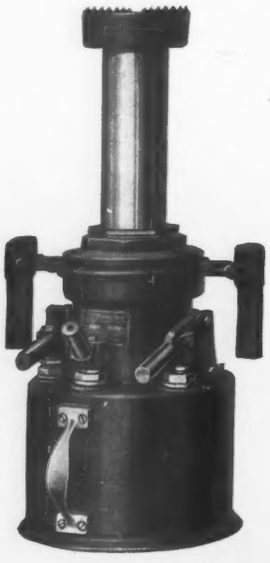
Seventy-Five Ton Hydraulic Jack

A 75-TON model has been added to the line of hydraulic oil-power jacks manufactured by the Blackhawk Manufacturing Company, Milwaukee, Wis.

This jack, Model G18, weighs 200 lb., very light for its capacity, and is equipped with special carrying handles to enable two men to carry it with little effort. Its collapsed height is 18 in., and it has a 10-in. lift, giving a total height of 28 in. The jack is also equipped with two pumps; a feed pump to quickly raise the plunger of the jack to the point of contact, and a power pump to raise the load. The load can be automatically lowered fast or slow, as desired, and under control. It can also be raised or lowered a fraction of an inch to a desired point. The release valve is entirely separate from the pump, and prevents accidental lowering. All working parts (pumps and Ball-Checks) are built on the outside of the jack.

An added feature is the check valve unit. This unit contains both Ball-Checks, and is the heart of the jack. It is easily removed for cleaning by simply unscrewing the pump.

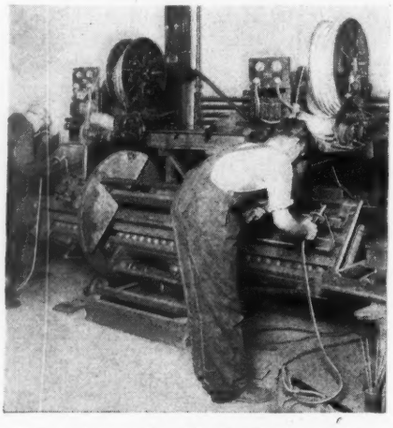
Blackhawk 75-Ton Hydraulic Jack



Metal Tie Welder

AUTOMATIC welding equipment for making metal railroad ties from scrap rail is announced by the General Electric Company, Schenectady, N. Y. By means of this equipment, it is claimed railroads can make their own metal ties, or manufacturers can build them for sale. The placing of this new machine on the market follows the discovery by William Dallton, announced earlier this year, that this type of tie is practicable.

The new welding apparatus developed for this work, it is stated, consists of an automatic tie-welding machine, and a 1,500-amp. motor-generator set with two circuits for hand welding and two circuits for automatic welding. The following equipment is involved: 1. A section of a roller conveyor on which the rails are moved into position for welding. 2. A jig for correctly spacing the rails and locating the tie plates on top of rails. 3. Two pneumatic plungers for rigidly holding these parts in position. 4. A pair of spring and toggle operated clamps for holding the angle iron against the ends of the rails. 5. A mechanism which rotates the whole jig with its rails and plates. 6. Two automatic welders mounted on individual travel carriages for welding the two tie plates simultaneously. 7. A track on which the travel carriages ride. 8. A supporting framework. The assembly is shown above.



G.E. Automatic Metal Railroad Tie Welding Machine

For maximum production the machine requires two operators, one for each of the two automatic heads. Each head has a separate control panel, thus making each operator largely independent of the other. Estimated output of the machine, with two operators, is one tie every five minutes.

Adjustable Lamp

DISTRIBUTION of a new type of adjustable lamp for use on bench or machine, in office or home, and on drafting or work table, has been announced by Edward Holt Company, 6911-23 South Chicago Ave., Chicago, Ill. The Edon Lamp, according to the manufacturer, is 100 per cent adjustable and consists of three movable joints attached to a bracket by a swivel. The friction is between two phosphor-alloy plates which are connected by a steel farrow, thus assuring positive friction.

The flexibility of the assembly with the special brackets make the application unlimited, it is said. Eleven standard types of brackets, are available for mounting the lamp, which is finished in black Duco. A push-on swivel shade and artificial silk lamp cord with two-piece attachment plug are standard equipment.

Fully-Inclosed Motor

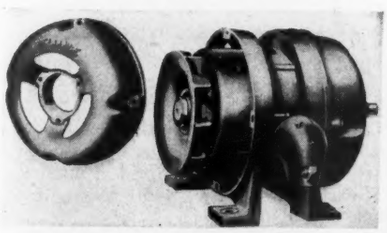
A FULLY-INCLOSED, fan-cooled induction motor, known as Type AA, has been introduced on the market by the Reliance Electric & Engineering Company, Ivanhoe Road, Cleveland, Ohio.

One of the principle features claimed for this fully-inclosed motor is that the method of ventilation employed makes it possible in most cases to operate the motor at the full open-type rating. Internal fans are used to circulate the air around the coil heads where a large part of the heat is generated. This causes the internal heat to be transmitted to radiating bonnets which entirely surround the coil heads and seal the motor against the entrance of dirt.

Across the outside surface of these radiating bonnets a strong blast of air is blown which absorbs the heat from the bonnets and carries it away from the motor into the surrounding atmosphere. This current of cooling air also passes across the outside of the stator core.

The outside blast of air is produced by large radial fans, one on each end of the motor shaft just outside the bonnet. The external fans are surrounded and protected by a standard bearing bracket such as is used on an ordinary induction motor. The additional parts required for the secondary ventilation and inclosing are all inside the motor. The external appearance and the mounting and limiting dimensions are the same as a standard induction motor of the same frame size.

Reliance Type AA Fully-Inclosed, Fan-Cooled, Induction Motor



Portable Light

AN EMERGENCY light, which is designed for constant use where operations are being conducted at a handicap due to conditions that are troublesome to ordinary lighting, is being marketed by the Motor City Electric Company, 316 East Jefferson Ave., Detroit, Mich. It is

Motor City Portable Light

claimed that this light, which is equipped with a 150-watt lamp, is effective to a width of 100-ft. at 80-ft. from the lamp. Primarily, it is a work light to facilitate indoor and outdoor operations that cannot be economically reached through permanent fixtures, and where conditions have to be met that are extraordinary. As this floodlight is designed watertight, gasproof and has a globe that will resist temperature change, it may be used under many extraordinary conditions, it is stated.

The shade is made up principally of a 14-in. RLM steel reflector, a globe holder of cast brass that is threaded for a guard and a globe, and the reflector, carrier and base are green enameled.

Direct-Reading Ohmmeter

AN OHMMETER that has been designed for rapid measurement of the resistance of coils and resistance units on a quantity production basis is being marketed by the Roller-Smith Company, 233 Broadway, New York, N. Y.

This instrument, known as Type COM, is a form of slide-wire ohmmeter, designed with particular reference to speed and simplicity of operation. There are four ranges, 0.5 to 50, 5 to 500, 500 to 5,000 and 5,000 to 50,000 ohms.

When operating this instrument the galvanometer needle is balanced at zero. Then the value of the unknown resistance can be read on the dial at the point opposite the register mark. The battery for this ohmmeter is self-contained and consists of two standard, cylindrical flashlight cells.

The instrument case is of black walnut, and the over-all dimensions are 5¾ in. wide by 9¾ in. long by 4¼ in. high. The net weight is 3½ lb.

Belt Conveyor Carrier

MARKETING of a new type of belt conveyor carrier, which is said to embody several improvements both in construction and design, has been announced by the Stephens-Adamson Manufacturing Company, Aurora, Ill.

The carrier is known as the Stephens-Adamson Simplex carrier; the complete line includes carriers for belts ranging in widths from 12 to 60 in. The carrier proper consists of three rollers in line, the troughing rollers being mounted at a 20-deg. angle in order to increase the capacity of the belt.

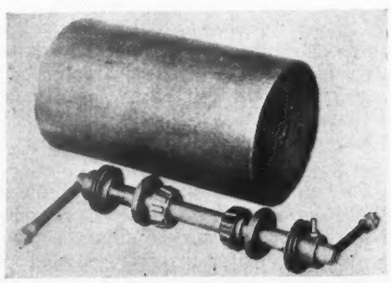
The rollers are self-contained units made of steel tubing, and are furnished with drawn-steel end plates. The ends of the rollers are mounted to prevent fraying, or wearing the belt. According to the manufacturer, each roller is equipped with two Timken bearings, which are mounted as follows:

The cones, or lower races, are pressed on to the roller shaft and located by a washer. The cups are pressed into a steel tube which forms the roller axle, and are located by shoulders in the tube. The bearings are protected from dust and other foreign substances by a combined labyrinth washer and multiple-groove grease seal. The permanent adjustment of the bearings is accomplished by means of lock screws.

The rollers proper are mounted on malleable-iron stands, which support the shafts close to the bearings and have large, flaring caps which assist in preventing the entrance of dirt into the bearings. The stands which support the outer ends of the troughing rollers are so constructed that it is a simple matter to swing them out of the way, and thus remove the roller bodily. This facilitates access to the center roller from either side, it is claimed.

The rollers are lubricated by the high-pressure grease method. Each roller shaft is equipped with two high-pressure fittings, one at each end, as indicated in the illustration, which project far enough to make them readily accessible. The shaft has drilled passages, which connect the fittings with the interior of the tube in which the bearings are mounted, the latter serving as a reservoir for the lubricant. A space has been left between the bearings and the outer closure into which grease is forced by the pumping action of the bearings themselves.

Disassembled View of Timken Bearings on Stephens-Adamson Carrier Roll Shaft



TRADE LITERATURE
You Should Know About

Copies of literature which is described on this page can be obtained by writing to the manufacturer whose name and address are mentioned. It is always advisable to state the name and number of bulletin or catalog desired, as given in these columns.

SOCKET WRENCH TABLE — A chart shows the application of socket wrenches to all bolts and nuts of U. S., S.A.E. and the new American standards. — Husky Wrench Company, Milwaukee, Wis.

ANTI-FRICTION COMPOUND—A compound for treating the oil used when breaking in bearings on new or reconditioned machinery is described in a circular.—Anti Hot Box Company, Inc., Princeton, Ill.

STEEL-PLATE BLOWERS — Fourteen pages of data are given in Bulletin 3504 on the type SE steel-plate blowers with ball bearings.—American Blower Corporation, Detroit, Mich.

PIPE HANGERS—Bulletin 2104 illustrates and lists the line of Wedgtite pipe hangers which are used to attach pipes or conduits to structural shapes.—Crouse-Hinds Company, Syracuse, N. Y.

SAW FILER—The line of Foley automatic hand and power drive saw filing and setting machines are illustrated and described in a folder.—Foley Saw Tool Company, Inc., 9-15 Main St. N. E., Minneapolis, Minn.

RUBBER BELTING — A circular lists and prices the various widths of plies of Copper Queen rubber transmission belts.—Pioneer Rubber Mills, 345-353 Sacramento St., San Francisco, Calif.

ELECTRIC TACHOMETER—Advantages claimed for the Pyro electric tachometer for indicating speed of operation are covered in a circular.—The Pyrometer Instrument Company, 74 Reade St., New York, N. Y.

ELECTRIC HOISTS — Catalog EH-106 describes and illustrates the new series of Hi-Lift electric hoists in ratings from 500 to 12,000 lb. capacity.—Northern Engineering Works, Detroit, Mich.

UNIT HEATERS—Catalog 42 describes the construction, operation and advantages claimed for the new Clarage unit heater for floor and ceiling installation. —Clarage Fan Company, Kalamazoo, Mich.

PNEUMATIC CONVEYORS — Bulletin 517 describes an installation of pneumatic conveyors for handling a powdered raw material; this assisted in doubling the manufacturing capacity of a plant.—The Dust Recovering & Conveying Company, Harvard Ave. and East 116th St., Cleveland, Ohio.

ELECTRICAL ACCESSORIES—A 56-page catalog describes and prices the M K line of plugs and sockets, switch plugs, switches and miscellaneous equipment. —M. K. Electric Ltd., Wakefield St., Edmonton, London, N. 18, England.

GASKETS — A folder gives information for ordering Flexitallic, a combination asbestos and metallic gasket, for pipe flanges, tube caps and manholes. —Flexitallic Gasket Company, Camden, N. J.

HERRINGBONE SPEED REDUCERS — A circular issued in advance of the general catalog, describes a line of generated, continuous-tooth herringbone speed reducers brought out by this company.—D. O. James Mfg. Company, 1114 W. Monroe St., Chicago, Ill.

MOTORS AND MOTOR GENERATORS—Bulletin 6023 covers the line of constant and adjustable speed d.c. motors with ball-bearings, in ratings up to 50 hp. on the constant speed motors and 25 to 30 hp. on the adjustable speed motors. Bulletin 6025 covers the line of motor generators up to 37½ kw. rating.—Engberg's Electric & Mechanical Works, St. Joseph, Mich.

FLEXIBLE COUPLINGS—The mechanical principles, lubrication, operation. rating, dimensions and other general information on Fast's flexible couplings are contained in a recent illustrated bulletin.—The Bartlett Hayward Company, Scott and McHenry Sts., Baltimore, Md.

ELECTRICAL REPAIR SHOP TOOLS—A folder of loose-leaf data sheets describes and prices the line of Peerless-Segur repair shop tools and supplies distributed by this company.—Electric Service Supplies Company, 17th and Cambria St., Philadelphia, Pa.

TIME RECORDER—Numerous instances of the results obtained from the application of Esterline-Angus time recorders in a wide variety of industries, together with a complete technical description of the equipment, are contained in Bulletin 1127. This instrument records, simultaneously, on a chart the time and duration of operations from 5 to 40 sources.—The Esterline-Angus Company, Indianapolis, Ind.

SPEED REDUCERS — Bulletin A describes the construction, gives dimensions and other data on the Albaugh-Dover line of spur gear and worm gear reducers and also the type C combination worm and spur gear reducers in which the worm is built in the spur gear reducer case. — Albaugh-Dover Manufacturing Company, 2224 Marshall Blvd., Chicago, Ill.

TRANSFORMERS — Descriptions of the important features of Moloney power and high-voltage transformers, radiator, type transformers, water-cooled transformers, and combination self and water-cooled transformers, together with instructions for their installation and care, are contained in Bulletin 234.—Moloney Electric Company, St. Louis, Mo.

STEEL RULE—The new Farrand Rapid Rule, a six-foot steel rule in a circular case slightly larger than a watch, is described in a folder recently issued.—Hiram A. Farrand, Berlin, N. H.

PULLEYS—A new booklet outlines the manufacture of pulleys made from compressed spruce.—Sprucolite Corporation, Bloomfield, N. J.

BEARINGS—Catalog 4A describes the Wide Series and Utility types of bearings.—Rollway Bearing Company, Inc., Syracuse, N. Y.

BATTERIES — The January issue of *Exide Topics* contains some interesting applications of storage batteries in hauling and conveying equipment. — The Electric Storage Battery Company, Philadelphia, Pa.

CHAIN DRIVES—A new catalog contains 156 pages of data on the design, construction and application of Morse chain drives.—Morse Chain Company, Ithaca, N. Y.

WELDED PIPING—This is the title of a booklet recently issued, describing and illustrating various ways of joining pipe by means of the oxyacetylene process.—The Linde Air Products Company, 30 East 42nd Street, New York, N. Y.

MICA CUTTER — Catalog No. 8 describes in detail the Hullhorst mica cutter. It can be fitted with both V type and U type saws.—The Hullhorst Micro Tool Company, 3242D Monroe St., Toledo, Ohio.

SPEED REDUCERS — Catalog 35 contains a large number of illustrations of installations, gives a complete description of the construction, with dimensions, rating tables, and other information on the Jones worm gear speed reducers. — W. A. Jones Foundry & Machine Company, 4430 West Roosevelt Rd., Chicago, Ill.